Health Website Usability Including a Motion Capture Study

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Supervisor

Associate/ Professor Dr. David Parry

By

Fawaz Alsabhen

School of Computer and Mathematical Sciences

ATTESTATION OF AUTHORSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning.

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NOTE

Regarding the pilot study, this thesis is interconnected to another thesis, and both were supervised by Dr. David Parry. As both studies were planned to conduct the same experiment using motion capture for usability testing for tablet PC within the clinical environment, the project protocol was divided into two parts. I conducted the second part of the project which involved the observation method and heuristic evaluation. The first part of the project, an interview and survey, was conducted by Hussam Aljamani. The data analysis and findings of both projects differed based on each study's problem statements and significance.

ABSTRACT

Use of tablet PCs within healthcare organisations provide many benefits for healthcare providers, as it improves contact between providers, as well as with the patients. Tablet PCs satisfy needs as clinical communication apps are available and progress in development. This research was conducted to find out the usability of tablet PCs by healthcare providers within healthcare services.

The usability testing method was designed to be obtained at a hospital. However, due to certain reasons the main experiment was cancelled; instead, a pilot study in MoCap Lab was used to simulate the healthcare environment for recruited participants. The aim of the study was to evaluate motion capture as a usability testing method alongside performing a heuristic evaluation for the navigated web side.

In the pilot study three participants were involved in motion capture session. All of their motion was recorded by motion capture instruments while performing their specific tasks using tablet PCs in a simulated healthcare environment. Next, the collected data were converted into 3D animator. In addition, data were collected from the website heuristic evaluation.

All movement were recorded effectively and accurately, which lead to consider motion capture protocol a usability testing method with the need to improve the software used for data analysis. According to heuristic evaluation, an expert's opinion should be considered regarding any website evaluation.

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CHAPTER ONE

1.1 Introduction

The emergence of internet technology has brought about a significant impact in nature and quality of service delivery within the healthcare system. The mobile phone devices have created a dire need for healthcare systems to step up their levels of service delivery to be efficient, swift, and tailored to fit the patient needs.

One such device that has proven to be of significant relevance within the current healthcare paradigm is the tablet PC. A number of researchers investigated the usability of tablet PCs in health care delivery. Most of these studies have postulated that the device is of great importance, and has the capacity to elevate the levels of healthcare delivery into higher ranks. For generation the healthcare system has dragged behind using traditional systems. However, advanced technological approaches have had a noteworthy improvement in the levels and nature of healthcare delivery.

This study focuses on how to enhance the user interface of the healthcare consultation system. Consultation is a good concept for getting experts together to share information and exchange opinions and advice in order to treat healthcare cases efficiently. In other words, patients will receive the required quality of healthcare services when experts come together to seek a solution to the given problem. Accordingly, this research seeks to investigate the significance of using the tablet PC in clinical consultation for the ordinary population in New Zealand.

Tablet PC devices are utilised in many aspects of private and public services due to its portability, storage capacity, connectivity, and screen size, which the mobile and the traditional PC cannot emulate (Mirza, 2008). As a result, there is rapid growth in demand for smart phones and tablet PC applications in the market.

According to Mirza (2008), healthcare services have always presented a mobile career with heavy loaded information. Therefore, the involvement of devices, such as tablet PCs, in the New Zealand health sector, are an important tool that will definitely enhance healthcare services.

Healthcare tablet PC applications constitute the key challenge when considering the effectiveness of implementing the use of these devices within the healthcare environment. Thus, the usability test will form the benchmark for measuring the effectiveness of the tablet PC applications. Motion capture (MoCap) technology will form the key aspect of the paper's experiment, and the findings will help in the analysis of usability levels of the device.

1.2 Problem statement

The use of traditional computers and file keeping systems have proven to be highly ineffective and time-consuming. Research regarding the use of portable mobile devices has provided clear indication that the use of such devices can significantly improve the quality and efficiency of healthcare.

The concept of clinical consultation using iPads and the role of iPads in providing a different consultation for particular healthcare cases was studied by (Marie, 2015). The study indicated a momentous success in the use of iPads in healthcare delivery. Given the level of success achieved by the use of such mobile devices, there is greater hope that the application of this concept can significantly change the nature of service delivery within the healthcare system. Eric (Eric.J., 2015) pointed out that the future of disease treatment will be on smartphones.

Literature from previous studies has pointed out the importance of using new technology in the healthcare sector (Caroll, 2002; Lee, 2013). The New Zealand government has provided a pool of resources aimed at improving service delivery within the healthcare system. Most of these resources have been in the form of monetary donations, increased number of medical personnel, improvement of healthcare amenities, and provision of information technology (IT) items such as computers and laptops to aid in service delivery. Nonetheless, a large number of healthcare institutions within the country are still experiencing high levels of inefficiencies. As a result, patients do not receive treatment on time and medical practitioners are unable to provide complete and comprehensive diagnosis of patient conditions.

There have been a rampant number of cases of chronic illnesses getting worse, and the sluggish nature of services delivered has resulted in the loss of many lives. The old system of using computers and records to capture patient information has also proved to be less effective. Computers were bulky and networking with other systems within the healthcare environment proved to be a great problem. Doctors and nurses could not walk with the computers, due to their large size, making it hard for them to deliver quality and efficient healthcare services. This presents a public health issue that needs to be addressed. The gap in quality healthcare provision needs to be filled to ensure that the population is given quick, effective, reliable and efficient medical attention. The findings of this research would be effective in coining creative solutions towards finding a solution to the problem.

This study focuses on the use of tablet PCs by nurses while interacting with patients. A number of studies have indicated a great success in using tablet PCs for service delivery (Bhatnagar, 2014; Knight, K., & Hunter ,2013). The findings of this current research would help in making proposals that would bring lasting change and impact in the service delivery within New Zealand's healthcare institutions. In addition, a mix method study sought to find the impact of using such technology to improve the user interface of the system.

The MoCap experiment is a process to digitally record the movement of objects or humans. The recorded motion data is mapped on a digital 3-2D software (Xsens, 2016). MoCap is currently used in many fields and could be taken an advantageous for using in the health sector. This approach would be used in determining the usability of the tablet PC and its impacts within the social panorama.

A health MoCap technique can usually be used with debilitated injured, chronic conditions that affect a patient's ability to move, as well as in physical therapy. However, this study is concerned with the issue of using MoCap as a usability testing method for healthcare application. Using tablet PC applications are critical to providing good health, and the user interface design plays a significant role in the acceptance of the application.

1.3 Research question

This study aimed to observe the behaviour of nurses while using the tablet PC with patients; and, at the same time, understand the usable interface design of the healthcare applications that they use. To do so, this paper attempted to answer the following research questions:

1. How does the tablet PC change the behaviour of the clinical consultation for specific ordinary people (normal people)?
   - a- How can we perform the usability testing using MoCap?
   - b- What are the issues of using MoCap?
   - c- What does MoCap add?
2. What user interface design issues does the Health Navigator website have?

1.4 Research significance

Doing this research will enhance the quality of health care in New Zealand. Using MoCap technology in usability testing important issues regarding the usability technique can be ascertained. In addition, there are no previous studies using MoCap in usability which makes this study the first of its kind.

1.5 Structure of the research

This research takes incorporates both qualitative and quantitative approaches. The paper is divided into five chapters. The first chapter has introduced the research problem, the research questions, justification of the research and the significance. The second chapter reviews the existing literature regarding the problem in question. The review involves an in-depth analysis of various research, their findings and implications. The third chapter presents a description of the research methodology used in the study. This mainly includes the response of the nurses towards the use of tablet PCs.

The fourth chapter is concerned with the pilot study and heuristic evaluation. Regarding the pilot study, two research projects were planned to run the same study with differences in observation and evaluation. The protocol of the pilot study was designed to be performed by the two researchers of both projects (see chapter five). Two experiments were planned; the trial test and the main hospital test (see Appendix A). However, due to ethical approval issues and lab maintenance works the main experiment was cancelled and an estimated experiment scenario and results were presented in addition to the trial pilot study. Finally, in chapter five the research results are presented and discussed. Recommendations for future research is provided.

CHAPTER TWO

2.1 Introduction

This chapter presents an analysis of existing literature regarding this research. Through a literature review, the researcher evaluates a range of ideas about the research topic to identify what is already known and where the gaps in understanding lie.

This chapter introduces usability and the quality components of usability, usability evaluations methods, and the importance of usability for healthcare applications. The portable devices that are used in healthcare are defined and the tablet PC as the portable healthcare device and its role in the healthcare organisations is introduced. The chapter further presents the discussion, which includes arguments about the problems and the impact of using such technology in healthcare.

2.2 Usability

The increased use of mobile technology has led to the development of various applications that can assist in executing certain tasks. In most cases, the developers tend to overlook the fact that the users of such systems may have difficulties in interacting with the systems. As such, the devices are designed with small screens, high power consumption, complex user interface, insufficient input modalities, and poor connectivity, amongst other issues. Devices such as tablets are meant to be used while one is moving. Their portable nature suits the various contexts within which they are supposed to be used. Within the hospital context, nurses, doctors, and other health practitioners, tend to move a lot in the course of their service. The usability of such devices is, therefore, a crucial factor in their success or failure for healthcare provider to help patients with their needs.

The International Organization for Standardization (ISO, 9241-11) defined usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (p. ?). In other words, usability is the measure that shows how the user interface fits the user's requirements and how easy it is for the user to use the product.

Different definitions and standards describe usability in various usability components. For example, (Shackel, 2009) defined usability regarding effectiveness, learnability, flexibility, and attitude. Meanwhile, (Jordan, 1998) defined usability as guessability, learnability, experienced user performance, system potential, and re-usability. Furthermore, effectiveness, efficiency, and satisfaction were considered the main three usability components by Nielsen (1994a). (Nielsen, 1994a; Shneiderman & Plaisant, 2004) defined usability as having five quality components as follows:

***Learnability*:** Learnability of the system design represents how easily the user can perform the main system functionalities when using the system for the first time.

***Efficiency*:** The efficiency of the system design is defined by how quickly the user can perform the system functionalities once he/she has learned and become familiar with the basic system design.

Memorability: The memorability of the system design shows how easily the user can start using the system again after a period of not using it.

Errors: This component shows how often the user makes errors while using the system functionalities, how serious these errors are, and how easy it is for him/her to recover from the performed errors.

Satisfaction: A satisfaction component shows how pleased the user is with the system design.

Different definitions of usability introduce various distinct usability components and goals. It is important to understand the difference between the various usability components and bear in mind that not all of them apply to the various types of interaction systems; different user interfaces need different usability attributes. Usability requirements and goals are the most important components for a one-system and depend on the type of system, including the context in which they are used for functionality, implementation, and types of potential users (Preece, Sharp, & Rogers, 2015).

When the usability requirements are identified, they are usually formulated in the form of questions. In this manner, usability goals are turned into usability criteria that are used for assessing the usability of a system in terms of how it can improve a user's performance (M. W. M. Jaspers, 2009). Some examples of usability criteria are time to complete the task (efficiency), time to learn a task (learnability), and the number of errors made when performing a given task over time (memorability).

2.2.1 Usability evaluation methods

According to the usability.net ("User observation/field studies," 2006) website, usability has several methods for evaluating user interfaces. The methods include usability testing, observation, and survey methods. Observation user method is one of the usability evaluation approaches that involves investigators watching the users while working in the field, and includes taking notes of the users' activity.

Today, numerous usability evaluation methods are widely used for identifying end user's requirements and developing user-friendly systems; such as usability testing, sort card, and expert evaluation. Different evaluation methods can be used in various situations, and the choice is usually closely related to usability criteria that is identified for the system, the phase in the development process, and the type of participants available for the evaluation process (Hartson, Andre, & Williges, 2001).

It is not just the end-users who are involved in the design process. Multidisciplinary experts and various stakeholders in the system (e.g., software developers, usability experts) can also give valuable contributions to the system development. Indeed, several usability evaluation methods can be used to include different types of stakeholders in the different phases of application design and the implementation process (Petrie, 2009). Therefore, the approach that uses different evaluation methods during one system design and development process, in addition to identifying and addressing the requirements of various stakeholders, is considered to be more efficient for creating a system that is highly effective and user-friendly (Mayhew, 1999; Norman, 2013). Accordingly, the following are short descriptions of some types of evaluation methods.

2.2.1.1 *Usability testing*

The usability testing process involves recruiting potential users and asking them to perform a carefully prepared set of tasks on the actual or prototype interface while measuring the typical user's performance (reaction times, behaviours, and errors) (Preece et al., 2015). Usability testing could be more successful and save time in the development life cycle. Neilsen (1994a) stated that three days are needed to complete the process. Usability testing is centred on user interface design for any system and is recommended for saving project costs.

2.2.1.2 Focus groups

Focus groups are considered a more informal technique and are usually used before the interface is designed or after it has been in use for a period to identify the users' needs and requirements (Nielsen, 1994a). A focus group session is usually semi-structured, where the moderator typically follows a previously prepared script. However, group discussions and interactions between participants are encouraged. In this manner, users can develop and express opinions within a social context, which is the main advantage of this approach over others.

2.2.1.3 Cognitive walkthrough

A cognitive walkthrough consists of simulating a user's problem-solving process at each point in the system design where the human-computer dialogue is performed (Nielsen, 1994b). The cognitive walkthrough is developed for interfaces that are intuitive and where users can learn them by browsing, but can also be utilised for interfaces requiring intensive training of users (Nielsen, 1994a; Shneiderman & Plaisant, 2004). Experts usually perform this technique, but results are commonly discussed in group meetings with future users, designers, and developers to initiate discussion and a joint problem-solving process (Shneiderman, 2009).

2.2.1.4 Heuristic evaluation

Heuristic evaluation is performed by reviewing the system design according to predefined rules and guidelines, and identifying interface elements that do not comply with these defined rules so that they can be modified and adapted through an iterative design process (Nielsen, 1994a; Shneiderman & Plaisant, 2004). Design experts usually perform the heuristic evaluation, but the evaluation can be also carried out by some application domain experts with usability experience to gain even more valuable and effective feedback (M. W. Jaspers, 2009). Literature reveals both generic heuristics that can be used for different types of system design (Nielsen, 1994b) and more specific heuristics that are adjusted for one type of terminal and/or system (Bertini, Gabrielli, & Kimani, 2006).

2.2.2 Usability in Healthcare

Many studies described usability in developed user interface for healthcare applications. However, there were only a handful studies that reported the results of evaluation of the clinical information systems and the user interface (Rodriguez, Murillo, Borges, Ortiz, & Sands, 2002).

Caroll (2002) studied the role of a clinical decision support system (CDSS) in supporting consultants' decisions in their work. The research was conducted to test the CDSS for cardiovascular diseases. Meanwhile, Santesso et al. (2006) studied a group of clinical experts, healthcare officials, and reviewers, to solve musculoskeletal diseases in the body. These diseases were investigated by conducting a meta-analysis on 50 selected groups. In another study, Lee (2013) considered the role of technology based on tablet computers in the healthcare system for the patients' well-being and treatment. A web based consultation system is an extremely useful system for seeking consultation with various experts in one attempt for a chronically diseased patient (Nynke, 2013). The concept of clinical consultation with using iPads and the role of the iPads in forming a different consultation tablet PC for a particular healthcare case were studied by (Marie, 2015). (Eric.J., 2015) stated that the future of disease treatment will be via smartphones. Doctors and scientists are joining heads to form tablet-based phones that can assist the treatment of patients.

2.2.3 Clinical Applications of Portable Devices

The literature revealed several applications for portable devices used by healthcare clinics; mostly these applications were for drug references, pharmacopeias, medical calculators, and patient trackers. Consequently, it was found that tablet PC drug and pharmacopeia's databases were useful resources for medical professionals (Crespo Perez, 2006). Also, (Adatia & Bedard, 2003) found that healthcare providers regularly need to do medical calculations, most commonly physiological parameters; severity guides; drug dosages; and decision support tools.

In addition, Rosenbloom (2003) found that several major American teaching hospitals routinely provide their physician staff with tablet PCs that are preloaded with the applications for drugs and medical references. Furthermore, portable devices have been used to observe patient's health and to inform the medical staff about the patient condition.

Additionally, Kimura, Onozaki, Shizui, and Ohnishi (2003) established a nurse care support system using personal digital assistants (PDAs) and tablet PCs with wireless and barcode readers, in order to reduce the costs of distribution, maximise the ease of the process, and adjust to existing structures and tasks of nursing care. It was found that this system reduced the learning curve time and was effective as a reference to support nursing care. However, reports revealed that side effects may arise while bringing in a barcode system. The study should be done with a new nursing path using the combination of mobile terminals and barcode system to avoid these side effects.

CARIS (cardiology information system) is a system developed at the LUMC department of Cardiology, City, Country, and is an application for computers running MS Windows operating system that includes all data concerning catheterizations, pacemaker implants and follow-up, clinical and interventional waiting lists, and other information. After selecting the patient's ID in CARIS, all data in separate information systems can be viewed; this is because the CARIS consists of a database server and numerous applications built with Borland Delphi, so it is linked to all clinical information systems in the cardiology department and the hospital information system. Meanwhile, the Coronary Care Unit (CCU) application includes sections for patient admission, daily reports, hemodynamic status, costs of diagnosis, and report for final discharge. Therefore, the CARIS user interface was designed to make the required typing works as small as possible through entering all the information via radio-button and drop-down lists. The program automatically generates a report by clicking the 'report' button. Moreover, when the patient is discharged, a final discharge letter composed from all sub-reports can be produced, which can be modified and adjusted through MS Word (Crespo Perez, 2006). In addition, Brobbel et al. (2001) pointed out that when the cardiologists have a useful portable device with a well-designed application, they can easily access all critical information required for achieving optimal patient care at the CCU.

Recently, portable technology usage has developed and increased within the healthcare environment. This technology increases the effectiveness and speed for collecting patients' demographic information, process drugs, and clinical laboratories prescriptions, in addition to improving the speed of drug dose calculations. Berner et al. (2003); Prgomet, Georgiou, and Westbrook (2009) emphasised that these handheld technologies are useful in ambulatory settings, access to information is rapid and easier, and data entry into electronic medical records is efficient, in addition to the reduction of risks due to errors during patient treatment.

2.2.4 The Use of Portable Devices in Healthcare

In the literature, multiple reasons explain why medicine supports the studies of potential markets and the role of the handy devices in clinical medical practice. For example, according to Fischer, Stewart, Mehta, Wax, and Lapinsky (2003), analysts predicted that 20% of physicians were going to use handheld devices for e-prescribing, ordering, checking lab tests, capturing charges, and writing notes. Additionally, Harris Interactive Poll revealed that 18% of the nation's physicians started using PDAs as an essential part of their professional duties (Ying, 2003). This survey further predicted that by 2005 the PDAs usage by physicians will increase nearly 50%.

Rosenbloom (2003) research in US hospitals found that between 44,000 and 98,000 people die annually due to medical mistakes, most of which can be avoided. Therefore, a constant need for newly developed technologies was strongly required to support clinicians in their work, since most of the medical mistakes were due to medication dosage miscalculations, wrong drug ordering, labeling, and packaging, in addition to nomenclature problems. To avoid some of these errors the Veteran's Administration (VA) had been used to take effective measures through the electronic system controls and applications. Accordingly, over a five year testing period at two VA hospitals in Kansas the medication errors reduced 70%; which represents an example for new and advanced national medical error-prevention systems.

There are a few studies examine the mobile patient monitors such as (Leung, 2013) where these monitors use to measure the patient status and send these data over a wireless network. The mobile monitors have a few advantage compared to the bedside monitor as the following:

- Mobility: the staff able to carry anywhere.
- Timely Alerts: notification can be sent immediately since the staff has access to mobile monitors at all times.
- More interfaces choices: ease of use and friendly

In fact, technological devices improve the effectiveness and the productivity of healthcare centres. However, since the usage of these devices worldwide are still in its early stages, more studies are required for improving these devices to enhance health services. Accordingly, Barrett, Strayer, and Schubart (2002) established a survey based on structured interviews in order to identify what medical practitioners find useful about PDAs, in addition to the issues that prevent and discourage the practitioners from using PDAs. Consequently, they could find what programs are currently used and considered valuable by the physicians. The results of this survey identified the tools and the features that are valuable for medical practitioners, in addition to the structures that disturb the residents or discourage using PDAs and tablet PCs. Results also revealed that software tools may increase medical practitioner's efficiency in the health field, and improve their clinical services and productivity (Mosa, Yoo, & Sheets, 2012). According to the initial survey findings, PDAs and mobile devices such as tablet PCs are highly used within the healthcare environment mostly in the areas of keeping patient information, medical calculators, medical references, and personal organisers.

2.2.4.1 Usability Studies of Portable Devices in Health-Care

Manuel and Pérez-Quiñones (2005) explained that portable devices provide convenience and mobile access to all required information anytime and anywhere in a clinical setting. Therefore, the usage of these technologies helps the clinicians to improve their tasks since these devices allow rapid accessing to physician's prescription, ease of clinical data collection, and provide a rapid reading of the patient records at the point-of-care through wireless technologies.

Staggers and Kobus (2000) compared the differences in nurses' response times, error rates, and satisfaction rating while using a text-based interface or a prototype graphical user interface (GUI) to accomplish nurses' documentation jobs to determine which type of the displayed interfaces is the best for user efficiency, effectiveness, and satisfaction while using the enterprise system. Results of this study showed that the GUI prototype considerably enhanced nurses' documentation response time, decreased error rates and improved satisfaction ratings in comparison with the existing text-based interface for nurses within the clinical environment. Moreover, the GUI prototype was easy and quick to be learned for controlling and ordering management tasks.

Other studies were conducted by the University of Puerto Rico (Rodriguez, Borges, Murillo, Ortiz, & Sands, 2002). These studies confirmed that the usage of a graphical-based interface decreased the time required from the physicians to perform some typical tasks on an electronic patient record system when compared with the usage of the text-based interface.

On the other hand, Rodriguez, Murillo, et al. (2002) study showed that when physicians are doing tasks that only require pointing and clicking, they are faster on PDAs than on laptops; while they are faster on laptops when performing tasks such as text entry and reading. Still, physicians were more satisfied with the actions carried out on the laptop than on the PDA. As a conclusion from Rodriguez, Borges, Soler, Murillo, and Sand's (2004) study, physicians' performance and user satisfaction are remarkably affected and improved by the vital element of the user interface for the PDAs such as the small screen and the text input methods.

However, Fischer et al. (2003) noted in their study that the current PDA applications have some restrictions for managing complete electronic records. Furthermore, Stausberg, Koch, Ingenerf, and Betzler (2003) study confirmed this limitation when the comparison was made betewen paper-based patient records and electronic patient records. Therefore, medical professionals should be alert to the probable differences between paper and electronic information. Also, they should keep in their mind the necessity to combine information from both records whenever it is required and appropriate.

As a conclusion from Rodriguez et al.'s (2004) usability studies of professional medical interaction with PDAs and laptops, it revealed that the use of PDAs for writing notes is significantly slower than laptop usage. Meanwhile, nurses, when performing bedside typical documentation tasks, are as effective with PDAs as with laptops, except when writing notes.

According to Manuel and Pérez-Quiñones' (2005) study, many users in the health environment indicated that tablet PCs are either too heavy or too bulky to be used in a standing position. Therefore, many users prefer smaller devices for this type of application. On the other hand, Chen (year) noted that the PDAs might be too small to effectively present a reasonable amount of information; whereas small tablet PCs are effective for processing the performed information.

Several report have revealed how device technology is changing healthcare delivery. According to Deloitte (2015) connected health, also known as Technology–Enable Care (TEC), involves health technology, digital media, and portable devices. It helps patients, nurses, and healthcare professionals access data and information more easily and effectively, and improve the quality of healthcare. Therefore, it is considered an essential part of the solution to many of the challenges facing healthcare and wellness sectors. In summary, tablet PCs are valuable in the clinical environment because of their portability and large screen. Nevertheless, these devices have some disadvantages.

2.2.5 Nursing Use of Portable Devices

In literature, several studies concerned the impact of involving portable devices within the healthcare environment. Other studies explored how portable devices improves nurses healthcare delivering and enhances patient outcomes (Carlton, Dillard, Campbell, & Baker, 2007; Farrell & Rose, 2008; Pattillo, Brewer, & Smith, 2007; Zgierska, Miller, & Rabago, 2012).

Di Pietro et al. (2008) conducted a cross-sectional, mixed method research study that included 51 participants from both hospital and home care nursing environments. In this study, the working task samples were selected and focus groups were used for data collection. As Di Pietro et al. noted, nurses usually look for information away from the point of care or in clinical information system and manuals or, most frequently, from nurses colleagues. According to the objective of Di Pietro et al.'s study, identification of resources that nurses frequently look for and access while using portable devices included; determination of patient outcome data and assessment data that have to be collected by the portable devices; identification of process of data collection; and what software system should be designed for these devices to increase its efficiency and usage within the healthcare environment. Consequently, Doran's (2007) research revealed that due to nurses' work nature, and the heavy workloads they practice, they usually face challenges in accessing information that is up to date, current, and timely. Consequently, as electronic resources are regularly accessed in the hospital setting involving drug reference information and compatibility guidelines, Doran found that the use of portable technological devices by nurses within the healthcare environment offers an opportunity to access relevant information at the time of nurse-patient contact.

2.2.6 Using Tablet PC in Healthcare

The use of PDAs and tablet PCs in healthcare have developed and progressed through the last few years. They have been shown to reduce errors in treatment of the patient, in addition to increasing the efficiency and higher speed of collecting patient's information; clinical laboratories requests; drugs prescriptions and doses calculation; and to access drug information (Prgomet et al., 2009).

Consequently, continued research is needed in order to improve technology integration and the use of devices in the area of medicine. Hence this chapter will review the literature regarding the potential roles of tablet PCs and its main issues relating to medical applications, in addition to software capabilities and restrictions.

Tablet PCs are technological devices used at the bedside for accessing and collecting clinical data. Rosenbloom (2003) noted that tablet PCs should be more developed and popularised, since they increase the convenience to access data, in addition to PDAs which are considered the most portable device for medical information.

2.3 Discussion

Multiple types of research and studies have pointed out that handheld mobile devices exhibit the greatest benefits in contexts where time is a life-threatening factor, and rapid response is essential (Prgomet et al., 2009). Therefore, according to (Bogossian, Kellett, & Mason, 2009; Jackson & Waters, 2005) research, the usage of the tablet PCs in clinical practice is increasing.

Accordingly, the advantages of using portable devices within the healthcare environment should play a great role in supporting and improving healthcare delivery and better patient outcomes and overcome the limitations relating to computer access. A study by Shortis, McGovern, Berry, and Farrell (2006) showed that using tablet PCs for nursing students improved their time management, enhanced communication, and increased the flexibility of students.

Thus, the advantages of using portable devices (tablet PCs, mobiles, etc.) within the healthcare environment can be summarised as follows:

First improved communication and accessibility between colleagues (physicians) and assistants (nurses) to achieve faster and more efficient patient care (Aziz et al., 2005) and improved patient outcomes.

Moreover, it overcomes the problems created due to the inadequate numbers of available fixed desktop computers which may limit regular data and information checking only available on fixed computers. Also, the electronic messages or decision support alert will be useless and inefficient if not received on time (Niazkhani, Pirnejad, Berg, & Aarts, 2009).

Furthermore, fixed computers positioned away from bedsides can cause an interruption in the workflow and further work due to the usage of first paper, then transferred to computer (Chan, Chu, Cheng, & Chen, 2004). This is a time-consuming process and speed and time limitations are part of this environment. Tablet PCs overcome this problem, increasing time-saving due to its availability at bedside at time of care.

Finally, keeping in mind, these portable devices still have limitations, including its small screen, which is designed for individual use (Dryer, Eisbach, & Ark, 1999; Gurses & Xiao, 2006). This may create challenges for easily viewing and entering data (Haller, Haller, Courvoisier, & Lovis, 2009); limiting a full viewing of patient information or hiding important information behind menus.

Several medical resources are required to be formatted for portable devices to be used within the healthcare environment to improve the care process and to achieve required patient outcomes. Furthermore, there are many companies that market a suite of these electronic resources. For example, drug reference database is one of the most required electronic resources providing information about the patient’s prescribing indications, integrations, compatibility with other drugs and patient contraindications. Clinical reference guides for nurses are also valuable electronic resources for novice nurses or experienced nurses. These guides provide nurses with the required information when they face uncommon medical conditions.

2.4 Summary

Usability testing helps evaluate a service or product with the representative user. During this test, participants are asked to complete a certain task while observers listen, watch and note important points. Here, the main objective is the identification of any problems during usability, collection of quantitative and qualitative data, and checking of user satisfaction level with the specific product. The main requirement for successful usability testing process is to develop a proper test plan, hire participants, analysis and then documentation of findings.

Usability testing technique for devices and PCs is becoming an important area to explore. It helps in collecting data under a controlled environment and assists in identifying usability issues that the consumer experience during the product usability. MoCap technique allows shooting at infinite angles at one time. It allows creative flexibility as well as enabling the deferment of various decision-making processes. It seems to be a logical conclusion as it is a complete replacement of conventional 2D cinematography into the 3D capture of every production type. More often, it is considered a type of capnography. It assists in the prior decision-making process by providing means for pre-visualisation as well as shoot planning. It provides flexibility for having proper experiments at all production stages through creating possibilities. Various areas help explore the amazing benefits of the MoCap technique.

Usability testing becomes more effective when it combines with the MoCap technique. It helps get real-time advantages from the environment. A real-time environment reduces expenses that take place in Key Frame Based Animation. MoCap makes no changes in the amount of work with varying length and complexity of performance, which was part of the traditional method. It allows enjoyment of various test results with different styles. Complex movements and physical interactions like weight, forces exchange, and secondary motion can be recreated easily in an accurate manner.

The animated data produced within a specific time is very large as compared to conventional animation techniques. This unique ability provides an economic and effective method to the users.

Healthcare institutes are facing various new challenges, including a consistent increase in expenses, medical issues and lack of facilities in rural areas. The development of wireless network becomes the source to improve communication especially among doctors, patients, and various other staff members. It is the easiest way to deliver accurate information anywhere and anytime while decreasing cost and barriers. In the same way, latest technologies are bringing various kinds of powerful and efficient medical applications.

Tablet PCs and laptops provide a fast and economic solution to the hospital staff. Nurses and doctors can organise meetings through various applications and solve issues while sitting in far off areas. They can consult with any specialist sitting at a specific place and take medical assistance. Nurses can discuss the situation of any patient with the doctor sitting at another place.

With the help of PCs, nurses can organise email consultation, which is convenient and cost effective, as consultation requires space and time. Tablet PCs enable nurses and patients to receive and send emails as they require.

In summary, to ensure successful integration of portable devices into the healthcare environment, the connection between the end users (physicians, nurses, and patient), system, the goals and the benefits of using such a technology have been considered in this section. Furthermore, there should be more studies; and healthcare providers should be consulted to understand their specific requirement about these technologies in order to ensure achievement of their need from using portable devices efficiently and safely, as well as to minimise user variances.

This chapter provides confirmation about how portable devices, especially tablet PCs, have positively influenced the environment of healthcare services through increasing speed of respond, decreasing the rate of errors, rapid information accessibility, and data management in a healthcare setting.

Chapter Three

3.1 Introduction

This chapter describes the study research methodology. This study aimed to observe the behaviour of nurses while using tablet PCs with patients; and to find the usable interface of the healthcare application. It was planned that the observation be conducted by a pilot study at local hospital in New Zealand. However, due to certain issues, this was not viable and so it was replaced by simulating the hospital and clinical environment in the MoCap Lab.

A heuristic evaluation and observation were chosen to answer the research questions. A mixed method was used to gather more data on the triangle of the study; nurse, patient and tablet PC.

3.2 Research Design

A mixed method approach is useful for gathering data and understanding the factors in order to answer the research questions. The literature demonstrates various methods in research where the chosen research methods depend on the research topic and objective (Patton, 2005). Research could be descriptive, exploratory, analytical or predictive (Saunders, Saunders, Lewis, & Thornhill, 2011).

The mixed method research is divided into two main parts; the quantitative approach where the human experience is understood through using numbers and statistics; for example, experiments, survey, correlation studies and slandered observation (Corbetta, 2003). Creswell (2013) argued that the quantitative method is a process of inquiry to understand human social problems based on creating pictures of problems that can be described by words, reporting details and conducted in a natural setting.

Patton (2005) described qualitative research as "subjective" in nature, highlighting the meaning, experiences, and descriptions. The main difference between quantitative and qualitative research is that the qualitative research is the interactive observation that follows the theory where the quantitative is structured, and theory follows observation (Corbetta, 2003).

Mixed methods are useful in research where the researcher tests a hypothesis. However, the main aim of using mixed method is to improve the reliability and validity of the research (Thomas, 2003). For this research a mixed method approach was adopted to achieve the study objective; observation and heuristic evaluation methods are used to understand the relation between the new technology (tablet PC), health staff and patients. Both methods give useful data of the impact of using such technology on healthcare staff.

3.3 Usability Evaluation

In this project, we sought to gather information about the usability of the healthcare system and the impact of this technology on improving the healthcare quality. The heuristic evaluation method was used to determine the effectiveness of the interface used in healthcare in order to provide a designer suggestion to refine the interface.

Dix (2004, p. 319) listed three main goals of usability evaluation;

1- To assess the extent of the system functionality

2- To evaluate the effect of the interface on the user

3- To identify the specific problems with the interface

There are a number of usability evaluations (Dix, 2004; Sharp, Rogers, & Preece, 2007; Shneiderman & Plaisant, 2005) as summarised in Table 1 below.

Table 1: Classified the usability evaluation source form (Hartson, Andre, & Williges, 2003)

Derived classification	Preece (1993:118)	Shneiderman and Plaisant (2005:140)	Dix et al (2004:361)	Preece et al (2002:345)
Empirical evaluations	Experimental	Controlled psychologically-oriented experiments	Empirical methods: Experimental evaluations	Experiments or benchmark tests
Model-based evaluation methods	Analytical methods	Acceptance testing	Model-based evaluations	Interpreting naturally-occurring interactions
Expert evaluation methods	Expert	Expert reviews	Heuristic evaluation Cognitive walkthrough Review-based evaluation	Predicting the usability of a product
Observational methods	Observational	Evaluation during active use Usability testing and laboratories	Observational techniques Monitoring techniques	Observing and monitoring users' interactions
Query techniques	Surveys	Surveys	Query techniques	Collecting users' opinions

The following are brief descriptions of each methodSharp et al. (2007) listed the following evaluation methods:

1. **Analytical evaluation**: formal and informal description of the interface to assess the user performance
2. **Expert's evaluation**: experts of user interface assess the system
3. **Observation evaluation**: monitoring or observe users' behaviours while they are dealing with the system
4. **Survey evaluation**: drive user's opinions of the user interface usability

5. **Experimental evaluation**: a scientific experiment applies in order to test a hypothesis about user interface usability
6. **Experts' review**: including techniques such as heuristic evaluation, guideline review, consistency inspections, cognitive walkthrough and formal usability evaluation
7. **Usability testing in laboratories**: including thinking aloud protocol, video typing and field-testing using mobile equipment
8. **Acceptance testing**: researchers use objective and measurable goals in the system. As a substitute for using subjective criteria like user feeling or friendliness, measurable criteria are set such as the time of user to learn the new system, number of errors, speed of task and user retention of comments over time
9. **Evaluation during active use**: include interviews and focus group, online telephone consulting, online suggestion box, online bulletin boards and feedback by newsletters and conferences
10. **Controlled psychologically-oriented experiments:** include **c**ontrolled experimental trials

In the next section, the observation methods and heuristic evaluation used in the study will be explained.

3.4 Data Collection Methods

This study used two primary methods in order to answer the research questions as shown in Figure 1, on the following page.

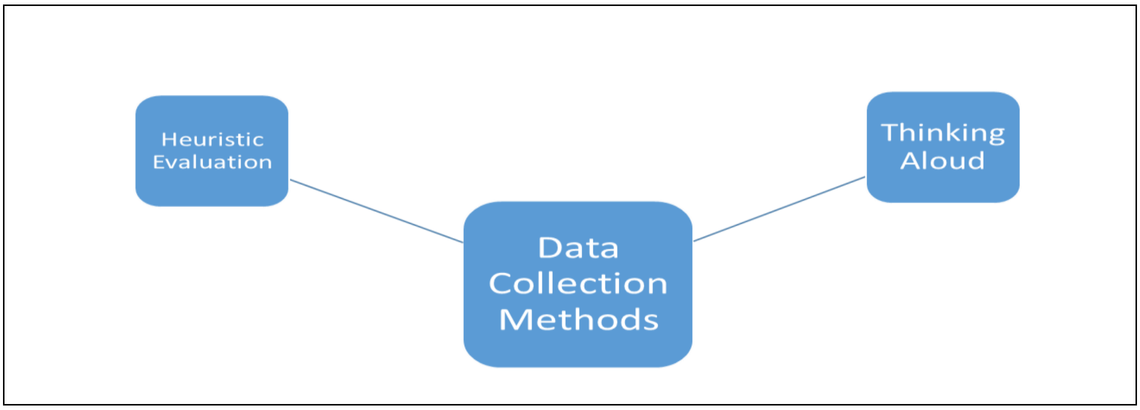

Figure 1: Data collection methods

3.4.1 Observation methods

Observation methods are performed by monitoring users while they interact with the real system. This observation may be done in the user's field or lab. Dix (2004) stated that the observation method could be conducted in a special place such as a usability lab or the workplace environment. The main advantage of observation method is the direct identification of the actual user's usability problems. The observation protocol was used in this current study. This technique has many advantages as explained in the following section.

3.4.2 Observation

Scientific investigations for usability depend mainly on observation to understand users' behaviour (Marczyk, DeMatteo, & Festinger, 2005). Observation could be either inconspicuous; that is an awareness of participant's behaviour without interference, or conspicuous awareness of a participant's behaviour with the intervention of the researcher. Commonly, inconspicuous observation is used in which participants feel comfortable and unstressed. Therefore, they do their tasks naturally (Marczyk et al., 2005).

The scientific observation can be defined as an investigative process performing accurate measurements in the context of the research. The outcomes of the observation method provide the researcher with the questions that are addressed through the scientific research. Therefore, strong observation of researchers' surroundings can provide them with many ideas and questions for their research studies.

Measurements methodology should be informative, cheap, and accurate, and absolutely within the context of the research to avoid biased observation. For example, for time observation the researcher should use timing measurement devices that have a high degree of accuracy and reliability, such as a stopwatch, so that the researcher ensures the measurement is accurate and not biased by external factors.

Often, daily life observations are not conducted accurately and systematically. Therefore, to gain an accurate measurement during investigation researchers use operational definitions. The operational definition refers to the researchers' definition of key concepts and terms in the context of their research study. Consequently, the researchers confirm directing all the participants' thinking and attention to the same phenomenon in a precise manner for the purposes of the study. As a result, the research observation outcomes will be more accurate and effective since all participants are concentrated on a specific point while performing their tasks. In addition, the clear definitions of the research terms allow another researcher to do more research and investigation on the same topic or phenomenon (Shaughnessy & Zechmeister, 1985).

3.4.3 Heuristic evaluation

In usability evaluation methods, heuristic evaluation is one of the most used methods. The method is based on three to five experts' inspection (Nielsen, 1995), who evaluate the user interface against a list of recognised usability principles. These principles help designers generally in ascertaining common usability problems (M. W. Jaspers, 2009). There are different usability heuristic evaluations such as the ten-usability heuristic (Nielsen) and the eight golden rules (Shneiderman, 2009).

3.4.3.1 Nielsen's ten-usability heuristics

In 1993 usability pioneer, Nielson, postulated 10 usability heuristics for evaluation. These are:

1- Visibility of system status: the system should keep users involved and informed of what is going on.

2- The match between system and the real world: the system should speak the user language and make information appear in natural and logical order.

3- User control and freedom: users need an emergency exit when they make mistakes; support users when they need help.

4- Consistency and standard: design should be harmonious, using same words and design.

5- Error prevention: design with less possibility of error and keep error messages clear and in right place and time.

6- Recognition rather than recall: make good actions, objects and options visible.

7- Flexibility and efficiency of use: allow for novice users to speed up the interaction with system. Design should be accepted by both experienced and novice users.

8- Aesthetic and minimalist design: design dialogues with necessary information to avoid irrelevant detail.

9- Help users recognise, diagnose and recover from errors: design should suggest a solution to help the user.

10- Help and documentation: the system will look better with help and documentation, so if the user needs any information it is easy to find.

3.4.3.2 Sheniderman's eight golden rules

1) Strive for constancy: layout, the language of use and any design element should be consistent.
2) Cater for universal usability: identify the requirements of diverse users and technology.
3) Offer feedback information: Keep user informed, every action from the user should be followed with feedback.
4) Design dialogues to yield closure: help users to know what they finish from their tasks.
5) Offer error prevention and simple error handling: clear information and error management.
6) Permit easy reversal of action.
7) Support internal locus of control: users need to feel they control the system, and the system responds to their commands/instructions.

8) Reduce short-term memory load: make menus and user interface elements visible and easy to find.

According to M. W. Jaspers (2009) to perform heuristic evaluation, the exporter steps through the interface twice. First, to get a general idea of the scope of the system and navigation structure. Second, to focus on the screen layout and get more details. Each expert has a result of usability flaws concerning the heuristic violated after the problems are found. The experts evaluate each problem independently (Nielsen, 1995).

3.4.4 Motion capture (MoCap)

MoCap is the method of recording objects or people movements, which is used for research in different fields such as military entertainment, sport, medical application, and for computer and robotic vision. In filmmaking and video games development, the movements of the actor are recorded to animate digital character model in 2D or 3D computer animation. When MoCap includes recordings for face and figure action or capturing precise expressions, it is referred to as performance capture (Holroyd, 2008). Usually 2D human studies, together with observation, are used to understand and evaluate the ergonomic aspects of a product.

The MoCap technologies include different types of systems. Systems can be separated into “real time” capture system where no post processing is required and the “non–real time” capture system where post processing is required to analyse and process the data. However, the classification “optical” and “non-optical” systems are the two main reliable types. Both systems have advantages and disadvantages; though the optical method is the system of choice due to its high level of accuracy and freedom of movements (Menache, 2000).

Optical systems: These systems depend on markers that are attached to the actor's body. These markers could be directionally reflective, light emitting, or coloured balls. The systems require several cameras (minimum of 3 and up to 16), which are used to follow and determine the 3D position of the markers within a specific area, usually called the MoCap stage (Bhaltilak, Kaur, & Khosla, 2014). The higher number of cameras involved, the more number of markers will be tracked at once; consequently, more accurately captured data will be produced.

Optical systems can be differentiated by the type of markers used. Passive markers are balls coated with either reflective material that reflects the light generated near the camera, or coated with a vibrant colour (refer Figure 2). Active markers consist of a single or multiple LEDs that emit their own light. There are other types of makers, such as time modulated active and semi-passive invisible markers, which are less frequently used (Bachynskyi, Oulasvirta, Palmas, & Weinkauf, 2014).

Figure 2: The passive markers in motion capture

The non-optical systems are non-marker devices. For example, the mechanical MoCap system involves an exo-skeletal type suit attached to the actor and at each joint there is a sensor collecting information about each movement, which will be transferred to the computer for real-time processing (see Figure 3). Despite the low-cost of the mechanical system, compared to optical systems, its suit is restricted and can only record major movements (Bhaltilak et al., 2014).

Figure 3: Mechanical exo-skeletal suit (sophie, 2009)

The second system is the magnetic system. This system uses six or more sensors, which are placed on the body to measure the low-frequent magnetic field that is generated by a transmitter source. A control unit connects the sensors and the magnetic sources which calculates the location of the sensors in the field. Its inaccuracy in data collection due to magnetic interference is one of its major problems. Additionally, the recorded information is transmitted through cables which increases the weight and bulk of the sensors, making it difficult to use (Owen, 1999).

Finally, the third most common used non-optical system is the gyro system. In this system small inertial gyroscopes are connected to the body of the actor to record the body parts' rotation movements. Data is transferred by radio to receiver unit to be processed in real-time and mapped to a CG object. This system is easy to use and does not need the MoCap platform as it can be used on location (Shi, Wang, & Li, 2014).

Recently, the interest and development of using MoCap as a user research tool has grown. Therefore, researchers should understand the advantages and disadvantages of both optical and non-optical systems, so that they can decide which system is appropriate to their research as a user research tool. The following is a summary of the main advantages and disadvantages of both systems (Bhaltilak et al., 2014; Shi et al., 2014).

The optical systems are, in general, extremely accurate due to a large number of used markers. Furthermore, the performers are free to move since the collected data is transmitted wirelessly instead of cables. Additionally, the performance area is broad and large thus allowing high frequently captured data that increases the accuracy rate of these systems. On the other hand, the collected data through these systems requires extensive post processing and expensive hardware. Also, actions and movements should be done under a controlled environment to avoid reflective noises.

Meanwhile, the non-optical systems, despite their lower accuracy than the optical system, provides immediate feedback on the real-time output without requiring post-processing of data. Therefore, it is considered less expensive than the optical system and multiple performances can be captured. Nevertheless, its tracker's sensitivity to metals can lead to irregular outputs. Even more, the cables, in addition to the small capture area, add constraints to the actor. Finally, the configuration of markers is difficult to change, leading to a small sample rate.

3.5 Pilot Study

The pilot study was conducted on March 8th, 2016 at Auckland University of Technology (AUT) MoCap laboratory using a tablet PC. The pilot study used a small number of participants to test the methodology and analysis in order to apply the main study with a larger number of participants.

The research aimed to undertake usability evaluations of tablet PCs in a simulated clinical environment using the MoCap lab to see if this approach gives valuable information. After the pilot study, a few modifications were made to the tasks scenario and new tasks scenario were created. The pilot study provided an understanding of how to deal with MoCap equipments.

CHAPTER FOUR

4.1 Introduction

This chapter presents the pilot research study and the heuristic study. Regarding the pilot study, the main pilot study experiment was not fulfilled due to ethical approval issues and technical problems in the MoCap lab. Therefore, in this chapter, a trial pilot study, performed in a simulated clinical environment at the AUT MoCap lab will be discussed. In addition, a discussion for the main pilot study will be introduced.

As previously mentioned, the pilot was performed by two researchers as their objectives were the same and the protocol of this study was divided into two parts, where each researcher was responsible for a different role. Meanwhile, the task script and process was the same for both studies.

4.2 The Pilot Study (MoCap)

In this research, the pilot study was conducted to reveal how MoCap can be used as a usability testing method for using tablet PC within a healthcare organisation. The study task script was planned, and one trial test session was conducted to check the plan script, instruments, time needed, and everything related to the study before conducting the main study test. Thus, any modification to the study will be done, and any problem resolved.

The importance of the trial test was emphasised by many researchers. For example, Schade (2015) highlighted that the performance of a pilot trial test allows the researchers to do more adjustment for their main test to achieve the best usability study. Since these trial sessions were before the main test, they would provide an opportunity to evaluate the task wording, understand the required time needed to perform the task, validate the instruments, and supply additional data point to the study.

Regarding the pilot study and the trial test, the MoCap was the used method for usability evaluation of tablet PC within healthcare organisations. Hence, the MoCap lab was needed to simulate the required clinic's environment.

In the pilot study, the trial test session took place at AUT MoCap lab on March 8^{th}, 2016. Three participants were recruited. Three tests were done in the same session, where each participant played several roles based on scenarios, which were provided to them.

4.2.1 Participants

Three male participants from AUT were recruited in this trial test. All participants were international students and English was their second language. Their ages were 28, 27 and 35 (see Table 2, following page), and they were all with good health without any physical disability or medical problems.

As mentioned before, it was a trial test, so recruiting a small number of participants was adequate to fine-tune the usability of this study and to achieve the objectives of this trial test.

Table 2: Participants' demographic information

Participant	Age	Gender	Ethnicity	Major
P1	28	Male	Arabic	Master student
P2	27	Male	Arabic	Master student
P3	35	Male	Arabic	Secondary Supervisor

4.2.2 Objectives

This trial pilot study test was conducted to gain better understanding of how MoCap can be used for usability testing. It provided great insight about the study script, task strength and weakness. The following questions were investigated in this study:

- Is the MoCap considered the method of choice for usability testing?
- What does MoCap lab add?
- What are the main issues facing the researcher regarding MoCap?

4.2.3 The experimental procedure and tasks

At the due date, one crew member from the MoCap studio was present to prepare the experimental lab for the test session. He took 30 minutes for preparing the lab equipment, during which he explained how the equipment worked and instructed the researcher and the participants how to use them correctly in order to collect the required data.

The task scenarios were discussed with the participants and the crew member. The crew member suggested that the recording should be for the maximum 5 minutes; as this time length is adequate to collect as much data as required. In addition, data processing would be easier and save time rather than processing unnecessary or repetitive data. The researcher recommended this advice and was, as such, adopted.

Meanwhile, the participants were able to ask questions regarding the task and/or equipment. Indeed, they were excited and understood everything easily. An initial trial experiment was conducted before starting recording or wearing the suits. It was important to do such tests to ensure that the paticipants were familiar with the task instruments and steps to avoid mistakes while wearing the suits and having the system recording.

After practicing, the crew member asked the participants to wear the special lab suit. It took one hour for the participants to wear the suits and the crew member helped them, since it was the first time for them to wear such suits and they should be worn in a particular way and accurately. The crew member was highly cooperative, and the participants reaction was good and easy.

After wearing the suits, the crew member prepared the cameras and software for recording. In each test there were two actors. Therefore, at first, the system should identify each of the three actors individually; thus each actor stood in a T shape position and had to perform several particular movements, which were previously taught by the crewmember. These movements were captured by the system cameras, processed, and saved by the software as identification codes for the actor. This process took about 10 minutes and the position of the markers were not changed after that time.

Next, participants were ready to go through the tasks. A clapperboard was used to announce the beginning of recording (filming). The following page Table 3 explains the experiments that were done.

4.3 Data Analyses

Table 3: Participants' role

	1st experiment	2nd experiment	3rd experiment	4th experiment	5th experiment
actors	P1(nurse) and P2(patient)	P1(nurse) and P2(patient)	P2 (nurse) and P1(patient)	P1(nurse) and P3(patient)	P3(nurse) and P2(patient)
Scenario	It was only an initial trial, so actors practiced how to act.	The patient walked into the room, and the nurse welcomed the patient and started questioning him. The patient was happy with using the tablet, and there were no problems.	The nurse requested the patient to walk into the room, and then asked him to have a seat. The patient looked naive and uncomfortable using the tablet. It was quite clear that the patient feared to attempt to use the device due to fear of failure.	The nurse invited the patient in and asked him to have a seat. The patient did not know how to hold the tablet nor how to use it. The nurse had to advise on how the device should be held and used to feed in data.	The patient was quite nervous, because the nurse was so fast while asking the questions when using the tablet. The patient also feared to touch the tablet due to the markers that were attached to it.
Results	Achieved what wanted.	The patient was happy, and he thought it good to use the tablet for filling up some information.	The patient did not know how to use the test's used brand of tablet, as it was Samsung tablet PC. However, he was doing good after a while.	It was the first time for the patient to hold the tablet. So, he was not familiar with the tablet and did not know how to use it.	The patient was confused due to the reaction of the nurse. The presence of the marker made the patient consider the tablet too delicate to handle.
Voice recorded	No	No	Yes	Yes	Yes

The experimental collected raw data came into two main types: Written notes and Video data. The researcher collected the notes through observing the participants while performing the tasks. The video data were collected by the MoCap cameras and saved on the computers for processing and analysis by special computer software as discussed below:

4.3.1 Cortex

Cortex is motion analysis software (see Figure 4) for the treatment of all phases of MoCap within a single program including the initial setup, adjustment, tracking, and post processing. Hence, the collected data regarding single capture will be referenced in a single file location, which can be specified by the users according to their needs.

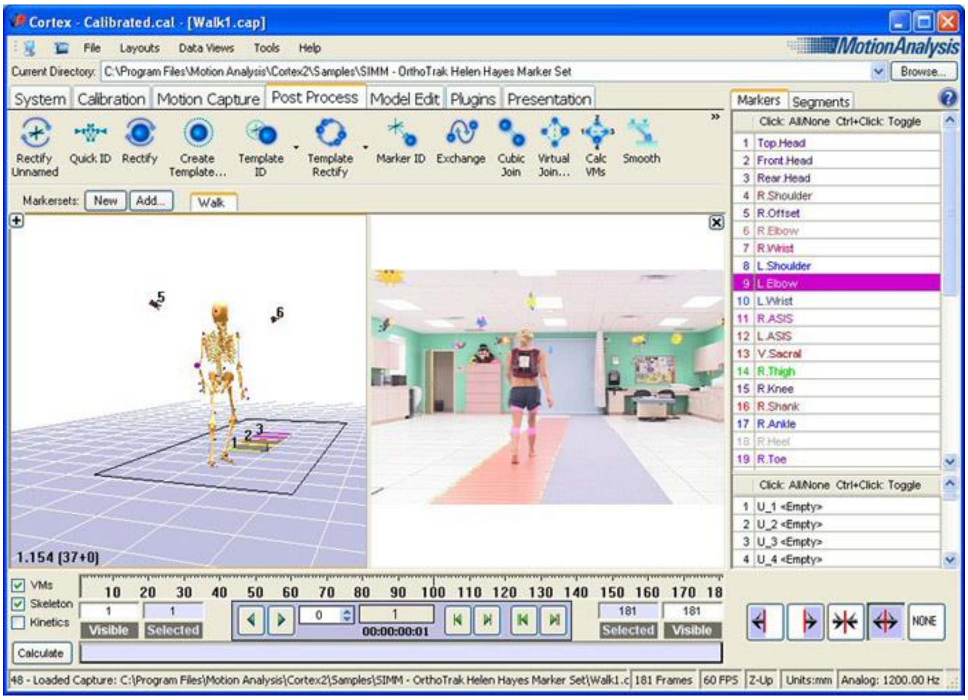

Figure 4: Cortex motion analysis software

Cortex receives the MoCap data from the markers attached to the MoCap suit, which represents the body movements. Therefore, it is important that the markers positions should not be changed, and no gap should be present between the markers.

In this study, makers were placed on the actors, and the used tablet PC, to identify each movement for each character alone. The recorded data regarding the capture were saved in a single file.

Motion "Rectify" was used when there was a gap in recording. The "rectify" can identify which marker was missed. However, if the information about the missed marker was found false and the system could not find the right one, then the recorded part of capture movement regarding this missed marker as deleted. Relatively, there were errors that ought to be fixed. For instance, development of random shaking while handling the tablet.

4.3.2 Motion Builder

Motion Builder is 3D character animation software that manipulates the collected capture data to character animation. In this study, after the Cortex refined the markers collected data, the Motion Builder was used to match this information with an animation character regarding the markers' positions.

Three animated characters were created: tablet PC animators that simulate the real used tablet PC, the nurse animator and the patient animator. All the markers on the suits of the actor and the tablet were transferred to its analogue animator; this process was time-consuming and took around 45 minutes.

Finally, all markers were matched and presented on the animators. Thus, all the captured movement presented and applied to the animators who performed movements were similar to its actor analogue. The researcher saw these movements on the screen performed by the animators.

It was nice to use these programs and helped us to see it as a real animation. However, it took time to build and collect data for only one experiment, approximately two hours. Therefore, the user cannot see the emotion of the characters' faces and cannot see the movement of fingers because there were no markers in there. Thus, while the patient or nurse is touching the tablet PC, the user cannot see the real touching or faces.

4.4 Heuristic Evaluation

Using the Nielson principles and guidelines presented in Chapter 3, we performed a 10 heuristic evaluation of the health navigator website. The evaluation was for website interfaces usability features against the list of standard usability principles, and to identify the usability issues. Several individual evaluations for the website interface were done through visiting the website and comparing the interface against a set of accepted usability heuristic.

4.4.1 Website description

The Health Navigator New Zealand is non-profit community, where the community website (see Figure 5, on the following page) is providing one place for New Zealanders to find trusted health information source. The website has been chosen because it is easily available and supported by New Zealand government.

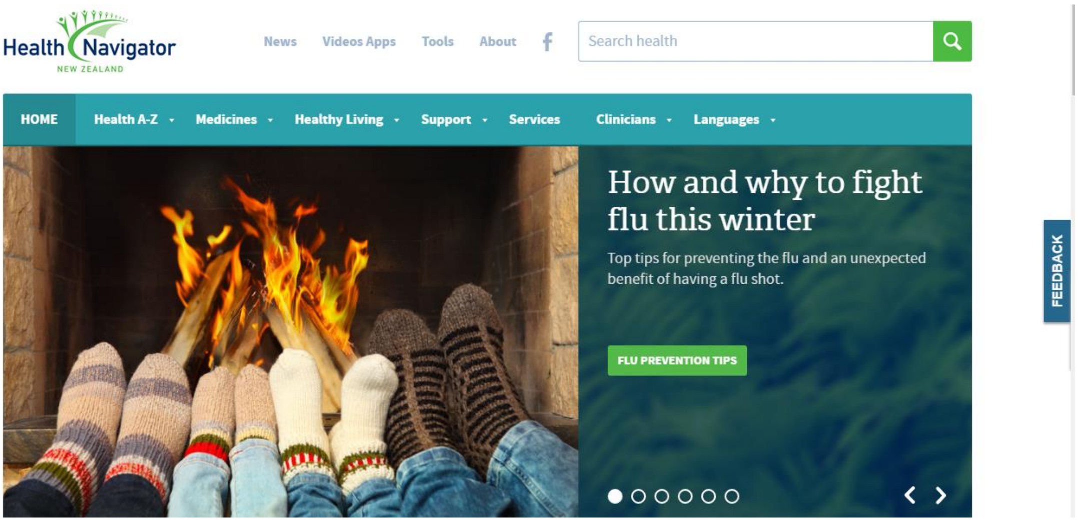

Figure 5: The Health Navigator website main page

4.4.1 Nielson heuristic evaluation

The following are the results from the Nielson heuristic evaluation sessions, where the heuristic was applied based on observation and trying. Each section will start with the Nielsen heuristic evaluation rule followed by the evaluation.

1. Visibility of system status

Always keep users informed about what is going on. Provide appropriate feedback within reasonable time.

Evaluation

The website was highly resourceful. It provided all the relevant information needed and clear steps to be followed. Figure 6 (on the following page) shows that the user got enough information while filling up any form, which made the user informed about what is going on.

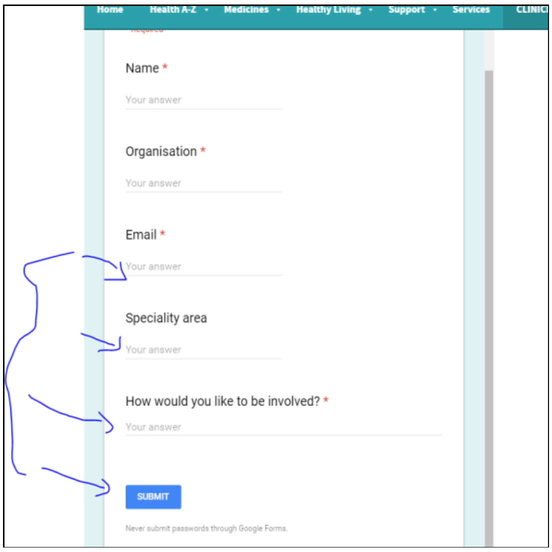

Figure 6: Visibility of system status

2. Match between system and the real world

Speak the users' language, words, phrases, and concepts that are familiar to the user, rather than using the system-oriented terms. Follow real-world approaches, making information appear in a natural and logical order.

Evaluation

The website supported multi-language, which is very useful to the user. In addition, the language that was used for the health terms was simple and easy to understand.

3. User control and freedom

Users often choose system functions by mistake. Therefore, a clearly marked "out" should be provided to leave an unwanted state without having to go through an extended dialogue; supporting undo and redo.

Evaluation

There was an excellent example of how this website uses the user control and navigation. Figure 7 (on the following page) shows how a user can know exactly the place of browsing.

Figure 7: User control and navigation

4. Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. They only follow the tailored system approaches to arrive at what they want.

Evaluation

Overall, the same layout and colours were used on all pages across the website. The location of each function and features did not change from page to page, as shown in Figure 8.

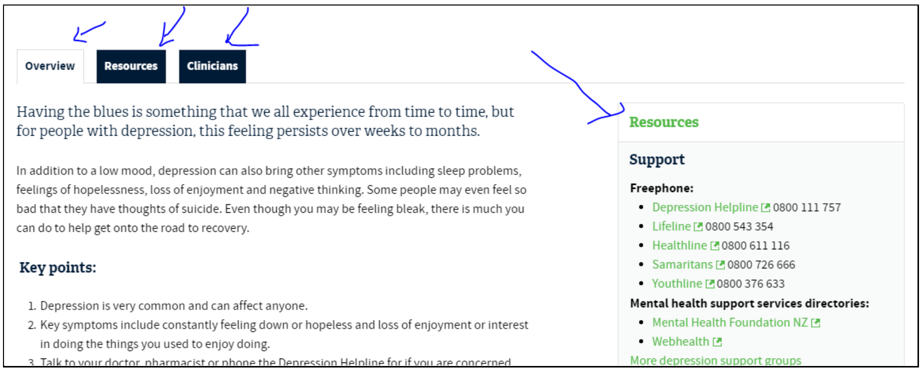

Figure 8: Layout for all pages is same

5. Error prevention

Even better than good error messages, is a careful design that prevents a problem from occurring in the first place.

Evaluation

Few pages required the user to enter any data; even so the design helps the user to select from a list, reducing user input and subsequently reducing the errors (see Figure 9).

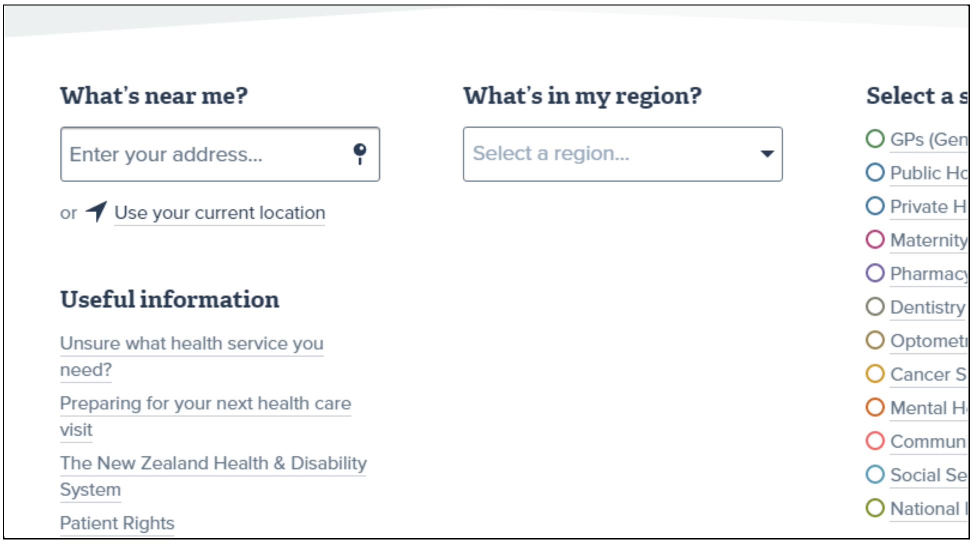

Figure 9: Example of the design reduces errors

6. Recognition rather than recall

Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for using the system should be visible or easily retrievable whenever appropriate.

Evaluation

It was clear that the website helped users to reduce effort and minimise user memory work. Figure 10 (on the following page) shows how users were told what they need to do.

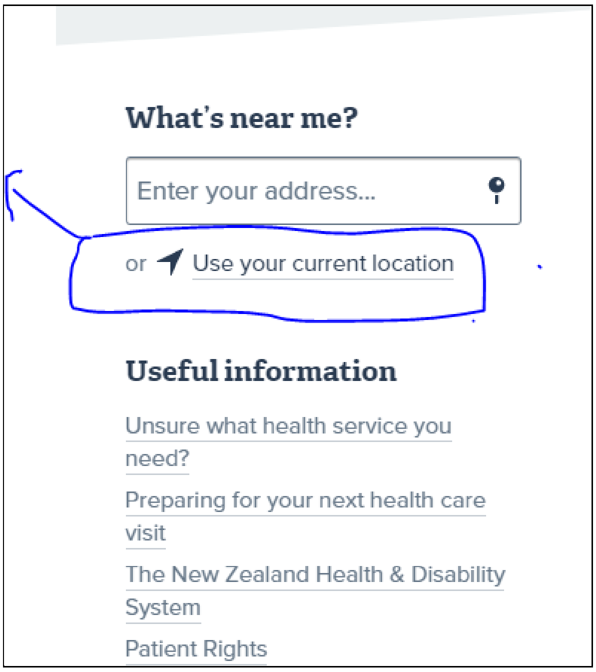

Figure 10: Minimize user memory

7. Flexibility and efficiency of use

Accelerators, unseen by the novice user, may speed up the interaction for the expert user so that the system can cater to both inexperienced and experienced users. It allows users to tailor frequent actions.

Evaluation

This prevented the users from experiencing any form of tension that may arise in the course of the experiment. Such tensions tend to minimise any fear that may distort the results of the findings.

8. Aesthetic and minimalist design

Dialogues should not contain information, which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Evaluation

This reflects consistency and standards. The competing units of information ensure that the user only interacts with the information that is relevant to his/her needs at that time. The design is, therefore, harmonic, and allows a way through which the information flow is balanced, in a manner that is not confusing to the user.

9. Help users recognise, diagnose, and recover from errors

Expressed in plain language (no codes) that precisely indicates the problem and constructively suggests a solution.

Evaluation

This is based on recognition rather than recall perception. The actions and options are made visible, making it easy for the user to translate, recall, or even weight the various available options. Considering this approach, the user can check on the errors and correct them in accordance to his/her perceptions.

10. Help and documentation

Even though it is better if the system can be used without documentation, it is recommended that documentation be there to provide help. Such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Evaluation

The help aspect makes the system interface easily accessible by novices. The availability of help options enables the novice users to interact freely and comfortably with the system.

4.5 The main experiment

The main purpose of the pilot study was to predict the possible outcomes of the main study. A number of concerns had been raised regarding the tablet PCs and their usability.

The concerns primarily revolved around their portability and the manner in which they affect people's movement during use. This study mainly focused on the usability of the tablet PC within a simulated clinical setting.

The original research was meant to take place at the hospital (see Appendix A); however due to certain ethical issues the project was stopped, eluding us the chance to perform the experiment at the hospital. The researcher, therefore, considered the use of a simulated clinical environment to provide the hospital setting. The ideal place for this was the AUT MoCap lab which comprised a large room fitted to bring more disks and computers with several infrared cameras linked to a central server (computer) that can be simulated. Just like in the trial pilot study experiments, the participants in this experiment would wear special suits covered with small reflectors. The tablet PCs are also fitted with reflectors. The infrared cameras track the motions of both the reflectors, and any slight movement of the objects was recorded. The key advantage of this approach is that it can be used in measuring any movement without necessarily creating a video of the same.

In this experiment, our original plan was to select student nurses and AUT staff to act as participants in the clinical setting simulator. Their roles encompassed the provision of health advice to the clients and making data entry. The participants were recruited through the primary supervisor's network. The experiment was expected to comprise of three main phases, the first was the pre-interview, followed by the simulated clinical encounter observation, and then a post interview. The study aimed to answering the following questions:

1. What are the benefits/issues that result from using a tablet PC within a clinical environment?

2. How does the MoCap application impact the experience of the usability evaluation?

3. Can a review of the MoCap data offer more information, first by the evaluator, and also with the participants involved?

4.5.1 The experiment participants

On the pilot test. The participants in this clinically simulated experiment were selected from AUT nursing students. Three students were selected; they spoke basic English, and were aged 25, 27, and 35. The selected participants did not have any physical or medical disability, which was an indication that they were in sound health.

Six patients were recruited through the supervisor's network. The participant patients were selected randomly from a group of students who had visited the college clinic and suffered from mild medical conditions. The rationale of the study was explained to the student clients (patients) and assurance was given that their anonymity would be maintained. The following (Table 4) presents the information regarding both the clinical nurses and the patients.

Table 4: Participant demographic information

Participant	**Age**	**Gender**	**Ethnicity**
P1	25	Female	Arab
P2	27	Male	Arab
P3	35	Male	Arab

4.5.2 Objectives

As mentioned in the previous paragraphs, this study was to be performed under three key objectives:

1. Research on the benefits and issues that may emanate from the use of tablet PCs within a clinical environment.

2. Find out the impact of MoCap while performing usability evaluations.

3. Review the extent to which review of MoCap data can elicit further information, first by the evaluator, and then with the participants.

The above objectives would form the benchmark of the study. The observations made would primarily dwell on the above-mentioned objectives.

4.5.3 The experimental procedure and tasks

On the research date, the original plan was planned to be done in the following order. It was expected that while the AUT MoCap lab was being prepared, the researcher would briefly explain to the recruited nurses the objectives of the experiment. They would be shown how to use the tablets and informed about the relevance of having the gadgets turned on. When the lab was prepared and fitted with the relevant infrared cameras the experiments commenced. The participants were requested to make any inquiry regarding the role they were expected to play. They all seemed to be contented with the information that was given to them. They were in good health and full of enthusiasm to handle the day.

The next briefing went to the patients. These students were to respond to the queries asked by the supervisor nurses. After suiting up, each of the patients were expected to have at least 40 markers on the body. Therefore, they were advised to ensure utmost care during the motion to prevent the markers from touching each other. The yellow corners were required to be within the cameras' field of view since the camera frames were 100 hertz. Missing on the yellow marks could have distorted the results.

As previously mentioned the experiment was meant to take place within a clinical environment. However, the simulated clinical environment was deemed ideal since it would present similar findings to that which were needed at the hospital environment. Each of the participant patients was to come in when the sessions were organised. They were to be given a brief welcome, followed by an introduction about the basics of the test. They would then proceed to the lab and pass through various simulated clinical scenarios, based on a recording of health data. Just as in the pilot study, the main experiment was approximated to take 5 minutes for each group. Observations were made by the main researcher and a recorded video was being done via MoCap. After which a follow-up session inquiring what happened at the experiments was expected.

During the experiment the participants were required to wear the lab suits on top of their normal clothing. These suits were fitted with reflectors to make them visible to the infrared cameras. The cameras were positioned in various parts of the room to enable the recording of each and every single motion.

The participants were not subjected to any form of pressure during the experiment, and the observations were primarily based on their experience while using the device and the software. The nature of participation was voluntary, and the participants were informed that they could withdraw at any stage of the experiment in case they felt uncomfortable as they were purely on voluntary basis. It was expected that the participants would exhibit high levels of cooperation and be prepared to undertake the experiment. They would be asked to practice what was to be done to make them more comfortable with the environment while wearing the suits and so that they understood what was expected of each person when the experiment commenced.

There were six experiments planned to take place which is convince for simulating. In the experiments, the patient should walk into the simulated clinical environment and go to the supervisor nurses. Information about each participant would be taken by the nurses. During the session, the MoCap recorded all the data regarding their movements and responses. A brief interview followed the sessions to allow participants to express their experiences while interacting in the simulated clinical setting. Table 5 below presents a summary of the experiments that were to be performed and the relative expected outcomes:

Table 5: Summary of expected experiment

Experiments	Actors	Scenario
#1	P1 (nurse) and C1 (patient)	The nurse should sit inside the room. The patient should walk in, greet the nurse and take a seat. The nurse should present the patient with the tablet, which he should take and begin to use. The patient should hold the tablet with one hand and use the other hand to make entries. Though not fast, the patient manages to enter the required information. The cameras record the position and the angle of change in the sticker.
#2	P2 (nurse) and C2 (patient)	The patient should walk into the room, be asked by the nurse to take a seat, and then presented with the tablet. At first, the patient was expected to look confused and sit down in a bending posture because he was unable to read the screen content due to vision problem (short sightedness). Nonetheless, with the bending posture, he managed to use the tablet successfully and fed in the data.
#3	P3 (nurse) and C3 (patient)	The patient should walk into the room. At first, looks a bit nervous. She will be invited to take a seat, and asked if she could use the tablet. The patient admits that she can use it since it bears resemblance with her cell phone. She should pick the tablet and may sit in a leaning posture on the seat, holds the tablet with one hand, and uses the other hand to enter the information that she was asked to enter.
#4	P1 (nurse) and	The patient should walk into the room, be asked to have a seat and presented with the tablet. At first, the patient looked uneasy, since he never interacted with the health

	C4 (patient)	clinic. After listening to the instructions from the nurse, the patient should make entries into the tablet with both hands, while having the tablet placed on the lap. There was no straining an indication that he was comfortable while using the device.
#5	P2 (nurse) and C5 (patient)	The patient should walk into the room and be asked to have a seat after the greetings. He is then handed over the tablet and should be asked to enter certain data. The patient seemed to be struggling to find the right position to hold the tablet. Finally, he manages to hold it upright, directly opposite his face. From this point, he began entering the information that the nurse wanted. The patient was slow but entered the right information.
#6	P3 (Nurse And C6 (Patient)	The nurse should invite the patient to come in. The patient walks in and takes a seat. She then should be presented with a tablet and given instructions on how to use it. The patient holds the tablet with both hands first and looks a bit uneasy. She then should manage to figure out what the nurse wants her to do and enters the required information.

The rationale for the above experiment was to replicate the human body in its form and functioning. The reflective markers were be placed on the subjects, with the Cartesian position of the markers relative to the coordinate systems tracked through the use of the infrared cameras. Thus, as the subjects engaged in the various physical tasks, within the clinical simulation setting, the motion history of the markers was recorded by the cameras.

In the above experiment, the cameras were expected to capture various motion data from the patients while engaging in various tasks. The movements were then combined into a single task, which was then used to translate the overall complexity or ease in which the activity was performed. The approach that was used in this experiment is posture reconstruction formulation. The following page (Figure 11) is a representation of positions used in the 3D motion capture.

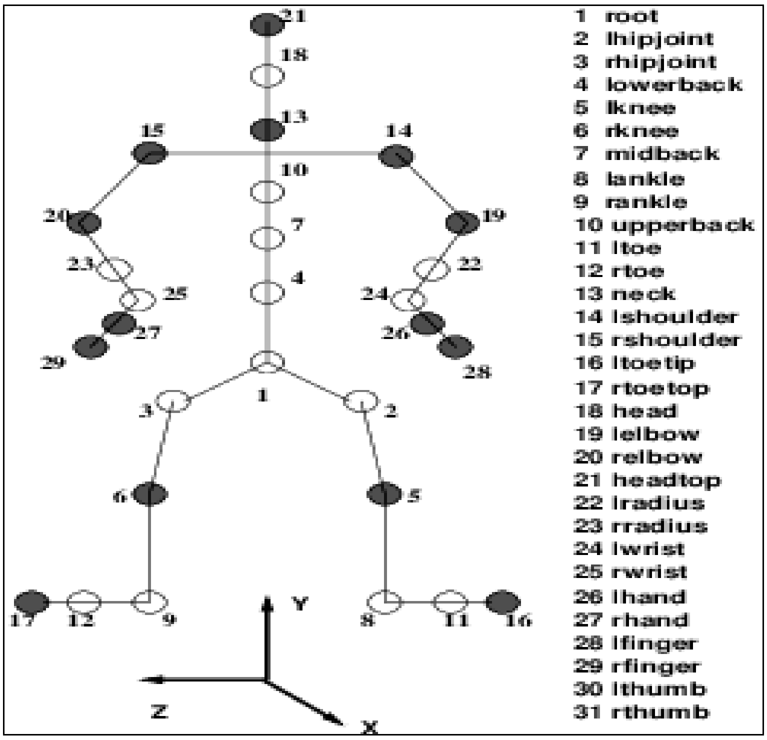

Figure 11: How motion capture detect marks

4.5.4 Cortex analysis

The motion information collected from the cameras were transferred to the Cortex. This motion analysis software treats all the motion phases captured in a single program. The captured motion raw data were then adjusted, tracked and processed to suit the required criteria. Through the makers attached on the patient, tablet PC, and the evaluator, the cortex captured the information and performed the sorting according to the set procedure. Gaps that were existent in the motion captures were filled, and no instance of the poorly captured marker should be witnessed.

4.5.5 The Motion Builder

After the Cortex, the processed raw MoCap data should be fed into the Motion Builder. The main function of the Motion Builder is to manipulate the processed collected motion data into animation. Each of the selected data should be matched with an animation character, depending on the marker positions. Just like in the case of the experimental pilot study tests, three animated characters should be established namely the patient, the evaluators, and the tablet PC. The analogue animator should match all the data with the actors, making them easy to analyse. The animators, therefore, should be played, and make motions similar to that which were made by the real actors. The Motion Builder animators made it easy to translate the motions of the actors and understand their relative motions and perceptions.

Despite the high levels of success that should be yielded in the results, certain aspects acted as a limiting factor in the experiment. For example; when the patients and the nurse evaluators used the tablet PC, it was not easy to read their facial expressions.

The reconstructions formulated using the above formula were expected to indicate that the majority of the patient's position showed high comfort levels. The majority of the research findings should indicate that the patients had the ability to use the tablets. The fact that they made correct entries should be an indication that the software interface is usable. A number of patients in this experiment asserted to the fact that they were in possession or have used a smartphone. Given such a history, the majority of the patients found it easy to operate the tablet PCs, which uses a similar operating system, hence have daily interactions with the screen touch. The tablets use the Android operating system which is highly common with many Smartphone.

The rationale for performing the experiment was to research the benefits and issues that may arise during the use of the tablet PC within the clinical environment. This research question seems to have been comprehensively answered. The response of the patients was expected to indicate the friendliness of the user interface of the tablet PC and that it can be used by any patient.

The positions that most of the patients expected to take while performing the experiment also depicted their levels of interactions with the interface. According to the expected results, most patients tried to use the tablets while sitting in upright positions. This is an indication that they can easily use the tablet PC within their seats of comfort; patients did not necessarily have to stand or take different positions to use these gadgets. Although it was expected that some patients may find the gadget to be quite big, it was hoped that most of them attested to the fact that they could easily operate the gadgets comfortably. The extent to which the stickers registered body motions depicted comfort and great convenience.

Analysis of the MoCap findings against the Nielsen 10 usability heuristics was expected to indicate that the usability of the tablet PC interface is friendly. This is because it was taken into account various elements of the Nielsen heuristic usability. For instance, it should present a proper user control and freedom, depict consistency and standards, present easy visibility of objects and options, and provide an easy way of documentation and representation. These are some of the heuristic thresholds that were set by Nielsen and managed to be adopted in the study.

The MoCap experiment aimed at measuring the human joints' motion within a MoCap experience. From the animators, it should be clear that motion sequence variances followed a given pattern respective of the actions that were being performed by the actors. For instance, most patients exhibited motions when stretching their hands to pick the gadgets. Others expressed motions when leaning forward or backward to enter information into the tablet. According to the observations in the posture reconstruction formulation, it was expected to be clear that the extent to which motion took place, did not have a severe impact on the patients. Since these devices required little motion, they could, therefore, be used by patients even in cases where they are not in perfect health. Within the posture reconstruction formulation, all the physical joint centres of the human body are considered end factors. This implies that every joint centre representing a physical joint position within the human body has a prescription to some point within the Cartesian space, and the same position is in correspondence with the MoCap experiment. Therefore, joints such as clavicle, elbow, and shoulder are considered end effectors, and possess associated distance constraints.

MoCap primarily predicts body motions relative to its functioning. Through such motions, the efficiency of various software or interfaces can be determined. The extent to which such motions occur reveal the levels of strain experienced by both the evaluator and the participant. The level of motion by the evaluator would reveal his/her ease or difficulty in using the device. Similarly, the same would apply to the participants. Besides motion, the MoCap model can also be used in predicting posture. Posture is highly important in determining the level of comfort experienced while using the software. The posture that the evaluators use while issuing or using the device can be used to define their levels of usability. Similarly, the postures that the participants use can largely predict the level of outcome that would be experienced in using the software interface.

The MoCap data, therefore, covers a wide scope, and can be used in predicting various variables within an experiment. With the increased use of mobile phone technology, many people are bound to use Smartphones, a factor that would enhance their levels of interaction with the software.

4.6 Summary

The pilot study was conducted to find out how MoCap can be used as a usability testing method for tablet PCs within the healthcare environment. Due to the previously mentioned reasons, the main planned pilot study was not conducted. However, a pilot study trial experimental test was performed. This testing session was recruited to examine the pilot study scripts, instruments, and time. Three participants were involved in this study and Samsung tablet was the used instrument.

Pre- preparation for the task was required. This preparation included the MoCap lab, the participants who should wear a special suit, and the instruments, which were the cameras and software. In addition, several steps needed to be followed during the sessions, starting by identifying the actors to the system and ending with simulating the movement action on 3D animators. The test session took about 4 hours to complete; some issues were faced and it required high concentration from the participants to avoid unwanted movement. Great attention to the markers was required since any changes in their position would produce false results.

Besides the pilot study, the main experiment was planned to be carried out within a hospital environment. However, due to unavoidable circumstances, the experiment could not take place. The researchers, therefore, opted to perform it in a simulated clinical setting within the AUT MoCap lab. This session was also cancelled due to lab maintenance. The experiment was planned to include both the supervisor nurses and the patients. Six MoCap experiments were planned to be performed and the response of the respondents evaluated against set criterion. Considering the predicted results, it was expected that the use of tablet PCs would have a significant impact in the healthcare setting. The results of the MoCap experiment were expected to reveal that the patients and the supervisors engaged in minor motions while interacting with the tablet software. In addition, the experiment was expected to show that given sufficient practice, patients and supervisors could perfect their skills of interacting with the tablet PC interface.

CHAPTER FIVE

5.1 Introduction

The study set out to explore the significance of using mobile devices within a healthcare environment. The study has indeed proven that the use of such devices can bring about a significant improvement in the quality and efficiency of the healthcare services. Some of the benefits accrued through the use of such services include enhanced decision making, increased quality of data management, easy access to data, and improved data exchange (Divall, Camosso-Stefinovic, & Baker, 2013). In addition, as noted by Mickan, Tilson, Atherton, Roberts, and Heneghan (2013), the use of such gadgets reduces the patients' hospital stay, thereby reducing expenses. This chapter provides a study summary, implications, and recommendations.

5.2 Importance of Tablet PC in Healthcare

The main research question was "How does the tablet PC change the behaviour of the clinical consultation for a specific ordinary people (normal people)?' The aim of this question was to find out the role of tablet PCs in clinical consultation, and if its involvement enhanced the process of consultation.

The tablet PC has had a significant role in changing and improving clinical consultations for the ordinary population. The widespread nature of clinics, inpatient wards, outpatient services, emergency departments, pharmacy, and labs provides an avenue through which the tablet PC concept can be implemented among the population (Mosa et al., 2012). The introduction of tablet PCs among the ordinary population can have a great improvement in the levels of healthcare provision. As seen in the current study, tablet PCs are easily portable, efficient in data storage, easily usable, and can serve communication purposes. This makes them easily used by both healthcare practitioners and patients in enhancing the quality of service delivery (Wallace, Clark, & White, 2012).

As the use of technology increases within the current system, health practitioners are finding more ways in which it can be used to enhance levels and quality of services offered. Despite the findings that indicated the inability of the patients to use the gadgets effectively, the widespread use of Smartphone technology among the population makes it easy for them to understand the tablet PC interface, and how to navigate across it. With such knowledge, the population stands to benefit a great deal from the use of tablet PCs.

In this research the pilot study was conducted to find out the manner in which usability testing for tablet PCs could be performed within a healthcare environment. The pilot study exhibited a high level of success, and the experiments performed revealed the viability of its usability within the clinical context. The results of the pilot study paved the way for the main MoCa[study that was conducted in a simulated clinical environment. The key objectives of the research were to establish the benefits and issues that may arise when using the tablet PCs, check on the significance of MoCap while performing the experiments, and review the extent to which MoCap can reveal more information regarding the procedure, both for the evaluator and the participants. These objectives have been fully met in the study, and most of the findings were in affirmative.

Most of the healthcare practitioners in the current social paradigm use tablet PCs and applications for various purposes. Such purposes may include administration, time management, consultation, gathering of information, and maintenance of patient's medical records (Clark & White, 2012).

Regarding the current study findings, it was found that tablet PCs can enhance and improve healthcare practitioners' work. Such enhancement includes convenience, improved decision-making, improved accuracy, increased efficiency, and enhanced productivity. These are some of the prerequisites of a healthy and productive health environment. These advantages of tablet PCs for healthcare services were also emphasised by multiple researches in the literature (Mosa, Yoo, & Sheets, 2012; Tilson, Atherton, & Roberts, 2013).

5.3 User interface design Usability

The user interface usability is a key component in the testing of many applications. It defines the ease with which the intended users can use the device to access various services. (M. W. M. Jaspers, 2009) proposed certain questions whose answers may define the usability of any given interface. Such questions include: *What is the time required to complete the task? What is the time required to learn everything about the task? How much errors occur while performing the task overtime?* (p. ?). The answers to these three questions help in finding out the efficiency, learnability, and memorability of the interface consecutively.

5.4 Motion capture

To answer the research question "How can we perform the usability testing using motion capture?", this research conducted a pilot study to indicate whether MoCap could be used as a usability testing method. The use of MoCap has proven to be effective in measuring the usability of the tablet PC. The MoCap replicated the human body, both in its form and functioning. The reflective markers helped in tracking any motion on the subjects; enabling the researcher to understand the levels of strain encountered.

The MoCap revealed various positions through which certain activities could be performed and how such positions affected the outcome. The MoCap experiment further depicted the ability of the patients and the evaluators to make entries into the tablet. Finally, the MoCap experiment has illustrated the manner in which posture can be evaluated while studying the user interface of the software. The posture reconstruction formulation revealed various ways through which posture can be used in determining the usability of a given interface.

The MoCap helps in evaluating the body joints of an individual while engaging in certain activities. The motions of the joints are then looked at relative to the Cartesian coordinate hence determining the impacts of such motions on the physical activities. This was the case with the patients. The use of this approach helped in determining the level of strain that the patients experienced while using the tablet PC interface.

Another question asked through this research “What are the issues of using motion capture?” Regarding this research and the pilot study, multiple issues were indicated as follows:

1. Commonly MoCap should be done in special labs where the environment is controlled and the equipment is uncommon for participants, which may affect participants’ confidence to perform their tasks freely.
2. Despite of the enjoyment and excitement that the “high tech” suit may add while wearing it, the markers present all over the body will lead participants to be uncomfortable and restrict their movement.

3. This method is considered a time-consuming process, as it requires a lot of preparation and the participants may get bored.
4. Participants' facial expressions and emotions, as well as the tablet PC screen activities, cannot be captured; and if so it will be very complicated procedure.
5. Finally, software for processing the raw captured data should be improved to allow easy interpretation of the raw data to 3D animator.

On the other hand, regarding the research question "What does MoCap add?" clear advantages could be notice while conducting the pilot study:

1. Data collected regarding the participant movement is precise, as participants movements could be taken from different angles.
2. Rapid method that real time data can be captured.
3. Allow many types of test to be performed with different styles and steps that multiple of participants can act at the same time.

Finally, regarding the research question "What is the user interface design issue that Health Navigator website have?" the Health Navigator New Zealand website was subjected to heuristic evaluation using the 10 Nielson principles and guidelines. There were no usability specialists, for example; people with experience in the user interface design. But, for the purpose of this study, the usability specialist was the researcher as an ordinary user for this website. As a result, for ordinary users (not experts) the real problems were not observable. For example, inconsistent placement of the same information in different screens may slow down the users for less than a second, which may accumulate with other sub-seconds slowdowns to cause major delay and cost for systems that are time dependant.

Consequently, the results of evaluation as an ordinary user indicated that there were no problems identified. However, if a specialist performed a deep analysis, multiple problems, minor or major, may be found.

5.5 Conclusion and Future Work

In conclusion, the objective of the study seems to have been comprehensively achieved. The study findings have pointed out that the use of tablet PCs within a healthcare environment can have a significant impact on the nature and quality of services provided. Both the pilot and the main experiment have illustrated the significance of MoCap experiment in determining the usability of the tablet PC.

5.6 Limitations

Despite the progress that has been achieved by the experiment, a number of issues surfaced during the use of the MoCap approach. The researcher found the process to be highly time consuming. This was mainly at the preparation phase when the lab was being set up and the representatives were being suited for the experiment.

The procedure was also seen to be highly sensitive since the participants had to ensure high levels of care while handling the markers. Any slight distortion from the markers would interfere with the experiment findings.

The process of data collection also had various issues. One such issue was difficulty in making a facial recognition or finger movement. This can limit the findings since the researcher cannot read the facial expressions or the mood of the patients. Added to the length of the procedure, the entire process is tiresome and requires much effort to accomplish.

Finally, the procedure for using the markers proved to be very hectic. For instance, the actors had to have the markers attached on their attires throughout the experiment. During the process, they had to exercise utmost care in ensuring that the markers did not fall off or get into a wrong position. This could cause a lot of discomfort; hence acting as a limiting factor to the success of the experiment.

5.7 Future Works

In the future, experiments should include software that can capture both facial and the finger motions. This would ensure high levels of accuracy in the experiment. The inference from the MoCap data are conclusive. However, inclusion of a video could help in making the results more efficient and accurate. The moods of the patients while using the devices could be used in determining their levels of fear or anxiety. Future works should consider this to improve findings.

Additionally, an attempt to make the MoCap environment and instrument more user/participant friendly is necessary. Also, development for the software is required to overcome the challenges of interpreting the raw collected data; for example, finding how to record tablet PC screen activity and link it with the actor movements.

5.8 Motion Capture usability protocol

Table 6: Motion Capture Usability Protocol

Phase	Fawaz	Hussam
Pre- Experiment	Outline scenarios	Identify Scenarios
Experiment – before MoCap	Heuristic analysis of software Finalise scenarios	Pre-interview Finalise scenarios
MoCaP	Observe interactions directly	Observe Interactions Via MoCAP
Post MoCAP	Review MoCAP- compare with direct observation notes	Review Scenarios with participants and MoCap and post-interview
Post experiment	Review issues and benefits together	

Rationale:

By having two experimenters involved this study will explore the potential benefits of incorporating MoCap into usability evaluation. One of the research team will play the part of the "patient" in each scenario.

Scenario's will include:

The health professional using software such as the stroke riskometer on the tablet, asking the questions and demonstrating the results to the "patient"

The "patient" using the tablet for data recording and showing the results to the health professional

Both "patient" and health professional going through a health advice website e.g. health navigator

Indicative questions for Pre- Interview

1) Are you familiar with the use of tablet PC devices ?
2) Do you use these devices in clinical care currently ?
3) What benefits do you think these devices can bring ?
4) What are the issues/ problems with using these devices ?

Indicative Questions for post-interview

1) Did you find you were able to behave naturally in the MoCap Environment ?
2) What advantages were there to performing the usability evaluations in the MoCap environment ?
3) Did you find the Tablet PC easy to use ?
4) What issues did you find with the Tablet PC ?

5) Would you incorporate Tablet PC use into clinical practice if you could ?

REFERENCES

Adatia, F., & Bedard, P. L. (2003). “Palm reading”: 2. Handheld software for physicians. *Canadian Medical Association Journal, 168*(6), 727-734.

Aziz, O., Panesar, S. S., Netuveli, G., Paraskeva, P., Sheikh, A., & Darzi, A. (2005). Handheld computers and the 21st century surgical team: a pilot study. *BMC medical informatics and decision making, 5*(1), 28.

Bachynskyi, M., Oulasvirta, A., Palmas, G., & Weinkauf, T. (2014). *Is motion capture-based biomechanical simulation valid for HCI studies?: Study and implications.* Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.

Barrett, J. R., Strayer, S. M., & Schubart, J. R. (2002). *Assessing the personal digital assistant uses and needs of medical residents.* Paper presented at the Proceedings of the AMIA Symposium.

Berner, E. S., Savage, G. T., Houston, T. K., Williams, E. S., Crawford, M. A., & Ray, M. N. (2003). Impact of patient feedback on residents' handheld computer use: a multi-site study. *Studies in health technology and informatics, 107*(Pt 1), 582-586.

Bertini, E., Gabrielli, S., & Kimani, S. (2006). *Appropriating and assessing heuristics for mobile computing.* Paper presented at the Proceedings of the working conference on Advanced visual interfaces.

Bhaltilak, K. V., Kaur, H., & Khosla, C. (2014). Human Motion Analysis with the Help of Video Surveillance: A Review. *the International Journal of Computer Science Engineering and Technology (IJCSET), 4*(9), 245-249.

Bogossian, F. E., Kellett, S. E., & Mason, B. (2009). The use of tablet pcs to access an electronic portfolio in the clinical setting: a pilot study using undergraduate nursing students. *Nurse education today, 29*(2), 246-253.

Brobbel, C., Witteman, T., Atsma, D., Schalij, M., Spruijt, H., Bosma, J., & Baljon, M. (2001). *Application of handheld computers for mobile access to a cardiology information system.* Paper presented at the Computers in Cardiology 2001.

Carlton, K. H., Dillard, N., Campbell, B. R., & Baker, N. A. (2007). Personal digital assistants for classroom and clinical use. *Computers Informatics Nursing, 25*(5), 253-258.

Carmen Caroll, P. M., Pat soden. (2002). Involving users in the design and usability evaluation of a clinical decision support system. *Computer Methods and Programs in Biomedicine, 69*, 123-135.

Chan, S., Chu, C., Cheng, B., & Chen, P. (2004). Data management using the personal digital assistant in an acute pain service. *Anaesthesia and intensive care, 32*(1), 81.

Corbetta, P. (2003). *Social research: Theory, methods and techniques*: Sage.

Crespo Perez, G. (2006). *A comparative study of nurses accessing electronic patient record systems with PDAs and tablet PCs.* (Dissertation/Thesis), ProQuest Dissertations Publishing. Retrieved from http://www.slideshare.net/GilbertoCrespo1/a-comparative-study-of-nurses-accessing-electronic-patient-record-systems-with-pdas-and-tablet-pcs

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.

Deloitte. (2015). Connected health How digital technology is transforming health and social care. Retrieved from http://www2.deloitte.com/uk/en/pages/life-sciences-and-healthcare/articles/connected-health.html

Di Pietro, T., Coburn, G., Dharamshi, N., Doran, D., Mylopoulos, J., Kushniruk, A., . . . Laurie-Shaw, B. (2008). What nurses want: diffusion of an innovation. *Journal of nursing care quality, 23*(2), 140-146.

Divall, P., Camosso-Stefinovic, J., & Baker, R. (2013). The use of personal digital assistants in clinical decision making by health care professionals: a systematic review. *Health informatics journal, 19*(1), 16-28.
Dix, A. (2004). *Human computer interaction*: Pearson Education.
Dryer, D. C., Eisbach, C., & Ark, W. S. (1999). At what cost pervasive? A social computing view of mobile computing systems. *IBM Systems Journal, 38*(4), 652-676.
Eric.J. (2015). The Future of Medicine Is in Your Smartphone. *wsj*. Retrieved from http://www.wsj.com/articles/the-future-of-medicine-is-in-your-smartphone-1420828632
Farrell, M. J., & Rose, L. (2008). Use of mobile handheld computers in clinical nursing education. *Journal of Nursing Education, 47*(1), 13.
Fischer, S., Stewart, T. E., Mehta, S., Wax, R., & Lapinsky, S. E. (2003). Handheld computing in medicine. *Journal of the American Medical Informatics Association, 10*(2), 139-149.
Gurses, A. P., & Xiao, Y. (2006). A systematic review of the literature on multidisciplinary rounds to design information technology. *Journal of the American Medical Informatics Association, 13*(3), 267-276.
Haller, G., Haller, D. M., Courvoisier, D. S., & Lovis, C. (2009). Handheld vs. laptop computers for electronic data collection in clinical research: a crossover randomized trial. *Journal of the American Medical Informatics Association, 16*(5), 651-659.
Hartson, H. R., Andre, T. S., & Williges, R. C. (2001). Criteria for evaluating usability evaluation methods. *International journal of human-computer interaction, 13*(4), 373-410.
Hartson, H. R., Andre, T. S., & Williges, R. C. (2003). Criteria for evaluating usability evaluation methods. *International Journal of Human-Computer Interaction, 15*(1), 145-181.
Holroyd, P. (2008). *Low cost motion capture system for the implementation of a real"time two"dimensional and three"dimensional mouse*. University of Sussex, Sussex,UK. Retrieved from https://www.sussex.ac.uk/webteam/gateway/file.php?name=holroyd-proj&site=20
Jackson, N., & Waters, E. (2005). Criteria for the systematic review of health promotion and public health interventions. *Health Promotion International, 20*(4), 367-374.
Jaspers, M. W. (2009). A comparison of usability methods for testing interactive health technologies: methodological aspects and empirical evidence. *International journal of medical informatics, 78*(5), 340-353.
Jaspers, M. W. M. (2009). A comparison of usability methods for testing interactive health technologies: methodological aspects and empirical evidence. *International Journal of Medical Informatics, 78*(5), 340-353. doi:10.1016/j.ijmedinf.2008.10.002
Jordan, P. W. (1998). *An introduction to usability*: CRC Press.
Kimura, E., Onozaki, Y., Shizui, Y., & Ohnishi, M. (2003). *Development of nursing care support system using PDA with wireless and barcode reader*. Paper presented at the AMIA Annual Symposium Proceedings.
Lee, M. E. P. H. (2013). The Strategy That Will Fix Health Care. *hbr.org*. Retrieved from https://hbr.org/2013/10/the-strategy-that-will-fix-health-care
Leung, K. Y. A. (2013). *Design guidelines for a mobile patient monitoring system.* UNIVERSITY OF HAWAI'I AT MANOA.
Manuel, J. C. M. A. N., & Pérez-Quiñones, A. (2005). The use of hand-held devices for search tasks in virtual environments.
Marczyk, G., DeMatteo, D., & Festinger, D. (2005). *Essentials of research design and methodology*: John Wiley & Sons Inc.
Marie, A. (2015). iCare: Evaluating the Usability of iPad Minis in the Clinical Setting. *aidsetc.org*. Retrieved from http://aidsetc.org/blog/icare-evaluating-usability-ipad-minis-clinical-setting
Mayhew, D. J. (1999). *The usability engineering lifecycle.* Paper presented at the CHI'99 Extended Abstracts on Human Factors in Computing Systems.
Menache, A. (2000). *Understanding motion capture for computer animation and video games*: Morgan kaufmann.
Mickan, S., Tilson, J. K., Atherton, H., Roberts, N. W., & Heneghan, C. (2013). Evidence of effectiveness of health care professionals using handheld computers: a scoping review of systematic reviews. *Journal of medical Internet research, 15*(10), e212.

Mirza, A. B. (2008). Potential of mobile devices in New Zealand healthcare: a thesis submitted to the faculty of Massey University at Albany in partial fulfilment of the requirements for the degree of Masters of Engineering in Software.
Mosa, A. S. M., Yoo, I., & Sheets, L. (2012). A systematic review of healthcare applications for smartphones. *BMC medical informatics and decision making, 12*(1), 1.
Niazkhani, Z., Pirnejad, H., Berg, M., & Aarts, J. (2009). The impact of computerized provider order entry systems on inpatient clinical workflow: a literature review. *Journal of the American Medical Informatics Association, 16*(4), 539-549.
Nielsen, J. (1994a). *Usability engineering*: Elsevier.
Nielsen, J. (1994b). *Usability inspection methods.* Paper presented at the Conference companion on Human factors in computing systems.
Nielsen, J. (1995). 10 usability heuristics for user interface design. *Fremont: Nielsen Norman Group.[Consult. 20 maio 2014]. Disponível na Internet*.
Norman, D. A. (2013). *The design of everyday things: Revised and expanded edition*: Basic books.
Nynke, V. (2013). Initial Implementation of a Web-Based Consultation Process for Patients With Chronic Kidney Disease. *AFM, 11*(2), 151-156.
Owen, S. (1999). A Practical Approach to Motion Capture: Acclaim's optical motion capture system. Retrieved from https://www.siggraph.org/education/materials/HyperGraph/animation/character_animation/motion_capture/motion_optical.htm
Pattillo, R. E., Brewer, M., & Smith, C. M. (2007). Tracking clinical use of personal digital assistant reference resources. *Nurse educator, 32*(1), 39-42.
Patton, M. Q. (2005). *Qualitative research*: Wiley Online Library.
Preece, J., Sharp, H., & Rogers, Y. (2015). *Interaction Design-beyond human-computer interaction*: John Wiley & Sons.
Prgomet, M., Georgiou, A., & Westbrook, J. I. (2009). The impact of mobile handheld technology on hospital physicians' work practices and patient care: a systematic review. *Journal of the American Medical Informatics Association, 16*(6), 792-801.
Rodriguez, N. J., Borges, J., Murillo, V., Ortiz, J., & Sands, D. Z. (2002). *A study of physicians' interaction with text-based and graphical-based electronic patient record systems.* Paper presented at the Computer-based medical systems, 2002.(cbms 2002). proceedings of the 15th IEEE symposium on.
Rodriguez, N. J., Murillo, V., Borges, J. A., Ortiz, J., & Sands, D. Z. (2002). *A usability study of physicians interaction with a paper-based patient record system and a graphical-based electronic patient record system.* Paper presented at the Proceedings of the AMIA Symposium.
Rosenbloom, M. (2003). Medical error reduction and PDAs. *International pediatrics, 18*(2), 69-77.
Santesso, N., Maxwell, L., Tugwell, P. S., Wells, G. A., O'connor, A. M., Judd, M., & Buchbinder, R. (2006). Knowledge transfer to clinicians and consumers by the Cochrane Musculoskeletal Group. *The Journal of rheumatology, 33*(11), 2312-2318.
Saunders, M. N., Saunders, M., Lewis, P., & Thornhill, A. (2011). *Research methods for business students, 5/e*: Pearson Education India.
Schade, A. (2015). Pilot Testing: Getting It Right (Before) the First Time. Retrieved from https://www.nngroup.com/articles/pilot-testing/
Shackel, B. (2009). Usability–Context, framework, definition, design and evaluation. *Interacting with Computers, 21*(5-6), 339-346.
Sharp, H., Rogers, Y., & Preece, J. (2007). *Interaction design: beyond human-computer interaction*. Chichester: Wiley.
Shaughnessy, J. J., & Zechmeister, E. B. (1985). *Research methods in psychology*: Alfred A. Knopf.
Shi, G., Wang, Y., & Li, S. (2014). Development of human motion capture system based on inertial sensors 2125. *Sensors & Transducers, 173*(6), 90.
Shneiderman, B. (2009). *Designing the user interface: strategies for effective human-computer interaction* (Vol. 3): Addison-Wesley Reading, MA.

Shneiderman, B., & Plaisant, C. (2004). *Designing the user interface: strategies for effective human-computer interaction*. Boston: Pearson/Addison Wesley.

Shneiderman, B., & Plaisant, C. (2005). Designing the user interface 4 th edition: Pearson Addison Wesley, USA.

Shortis, M., McGovern, J., Berry, M., & Farrell, M. (2006). Two case studies on the influence of mobile computing on student learning behaviour.

sophie. (2009). Animazoo Gypsy6 / Gypsy6 Torso Motion Capture Suits. Retrieved from http://souvrsophie.blog.com/2009/10/08/animazoo-gypsy6-gypsy6-torso-motion-capture-suits/

Staggers, N., & Kobus, D. (2000). Comparing response time, errors, and satisfaction between text-based and graphical user interfaces during nursing order tasks. *Journal of the American Medical Informatics Association, 7*(2), 164-176.

Stausberg, J., Koch, D., Ingenerf, J., & Betzler, M. (2003). Comparing paper-based with electronic patient records: lessons learned during a study on diagnosis and procedure codes. *Journal of the American Medical Informatics Association, 10*(5), 470-477.

Thomas, R. M. (2003). *Blending qualitative and quantitative research methods in theses and dissertations*: Corwin Press.

User observation/field studies. (2006). Retrieved from http://www.usabilitynet.org/tools/userobservation.htm

Wallace, S., Clark, M., & White, J. (2012). 'It's on my iPhone': attitudes to the use of mobile computing devices in medical education, a mixed-methods study. *BMJ open, 2*(4), e001099.

Xsens. (2016). Motion capture. Retrieved from https://www.xsens.com/tags/motion-capture/

Zgierska, A., Miller, M., & Rabago, D. (2012). Patient satisfaction, prescription drug abuse, and potential unintended consequences. *JAMA, 307*(13), 1377-1378.

Appendix A: Approval for AUTEC Ethical Application 16/101

14 April 2016

Dave Parry
Faculty of Design and Creative Technologies
Dear Dave

Ethics Application: 16/101 Tablet PC usability and motion capture in a simulated clinical setting.

Thank you for your ethics application. The Auckland University of Technology Ethics Committee (AUTEC) received your ethics application (16/101) at their meeting on 11 April 2016 and noted it. You are asked to reconsider the ethical aspects of your research, revise your application, and to present it again for consideration. AUTEC has noted the following for your assistance:

1. This application lacked sufficient information for AUTEC to be able to consider the ethical aspects of the research and is returned to the researcher and the applicant for completion;
2. A number of times in the application, 'convenience' was referred to in the responses. More clarification is required about what this means in each case and why this is justifiable;
3. Both the inclusion and exclusion criteria being applied to potential participants need to be reconsidered and clarified and consistently reflected throughout the whole document;
4. A picture in the Information Sheet of what will be involved would assist participants more that the current explanation;
5. The reference to interviews in the Consent Form needs further explanation or removal;
6. The Information Sheet needs to explain the research more adequately to participants.

If there is an issue around timeliness in the consideration of this application, then the completed application may be considered by a subcommittee consisting of the Chair, the Executive Secretary and the AUTEC Faculty Representative for Design and Creative Technologies.

Please provide me with your revised application which will be placed on the agenda for AUTEC's next meeting, where it will be reconsidered. The closing dates for the agenda of the next two AUTEC meetings are Thursdays 21 April and 5 May.

Please note that you are not permitted to commence research until AUTEC approval has been granted. If you do not submit a revised application within six months, your application may be closed and you will need to submit a new application to continue with this research project.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

Yours sincerely

Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Fawaz Alsabhen & Hussam Aljamani git2610@autuni.ac.nz; wxs7855@autuni.ac.nz

Consent Form

Project title: **Tablet PC Usability and Motion Capture in a simulated clinical setting**

Project Supervisor: ***Dave Parry***

Researchers: ***Fawaz Alsabhen, Hussam Aljamani***

○ I have read and understood the information provided about this research project in the Information Sheet dated 1 /05 /2016.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that notes will be taken during the interviews .

○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.

○ I agree to take part in this research.

○ I wish to receive a copy of the report from the research (please tick one): Yes○ No○

Participant Signature: ………………………………………

Participant name: ....

Date:

Participant Information Sheet

Date Information Sheet Produced:

01/05/2016

Project Title

Tablet PC Usability and Motion Capture in a simulated clinical setting

An Invitation

Hello, We are Fawaz Alsabhen and Hussam Aljamani and we are studying for a Masters in computer and information sciences at AUT

What is the purpose of this research?

We would like to find out if the use of a motion capture (MoCap) tool can help in evaluating the usability of a Tablet PC application in a simulated clinical setting. We would also like to explore what healthcare professionals think about using tablet PC's in clinical environments.

How was I identified and why am I being invited to participate in this research?

You have been chosen because you have a nursing or other clinical background and may be interested in the use of tablet PC's in healthcare. We have asked for people to participate via the networks of Dave Parry our supervisor.

What will happen in this research?

You will be invited to participate based on when the sessions can be organsed, We will give a quick welcome and information about the test. then there will be a short interview, and a explanation of what will happen. We will then ask you to go into the lab and go through a number of short simulated clinical scenarios - based around health data recording and advice, with a person pretending to be a patient. This will be observed and recorded via MoCap. After this we will ask some follow up questions and have you look at the moCap recording to comment on what was happening during the experiments.

MoCap involves wearing a suit on top of your normal clothes with small reflectors on it. The lab has a large number of cameras which record the position of these reflectors. A "stick figure" representation of your movements is created in the computer. This is the sort of technology used in "Lord of the Rings" etc.See the picture for an idea of what the MoCap suit is like

You shall be under no pressure throughout the entire session as this research is focusing on your experience of using the software and device, not your individual performance. All data collected will be only accessible for the researcher and his supervisor. Your identity will be anonymous in the written report.

Your participation is fully voluntary. You may withdraw yourself at any time during data collection and all data will be destroyed.

What are the discomforts and risks?

The motion capture suit covers your whole body except your face and feet. People may sometimes get a bit hot although the fabric is very light. Sometimes people feel a bit silly in the suit –although many people enjoy the experience. You may find that some of the set up time is a little boring.

How will these discomforts and risks be alleviated?

The people working in the lab are very used to people wearing the suits and you can take it off at any time. We would not expect you to be wearing the suit for more than 30 minutes total. The lab is not viewable except by people running the experiment and there will be no video taken – just the stick- figure recording. The scenarios are very short (up to 5 minutes) each.

What are the benefits?

- To identify whether MoCap is a practical tool in usability evaluation where multiple people are involved
- To identify what benefits may arise from using MoCap in usability evaluation
- To explore attitudes and issues associated with the use of Tablet PC's in a clinical environment

What compensation is available for injury or negligence?

None, this study designed to keep you fully comfortable and safe.

How will my privacy be protected?

The researcher and teacher/lecturer will assure the confidentiality of the participants. When writing up the report, real names will not be used. All the data collected will be securely stored and is only accessible for the researcher and his supervisor.

What are the costs of participating in this research?

A session of testing will take around 2 hours total.

How do I agree to participate in this research?

Please complete the consent form and return it within a week. .

Will I receive feedback on the results of this research?

The results and discussion sections will be sent to you either electronically or by post upon request. Summary of findings will be shared and disseminated with the participants as they are produced during the research in form of scholarly articles (conference or journal papers and thesis) to the participants wishing to receive such feedback.

What do I do if I have concerns about this research?

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 0064 921 9999 ext 6038.

Figure 1 : The bright lights are actually lightweight reflectors

Whom do I contact for further information about this research?

Project researcher and supervisor contact details*:*

Researcher: Fawaz Alsabhen Email <qjt2610@autuni.ac.nz>	Supervisor: Dave Parry dparry@aut.ac.nz
Researcher : Hussam Aljamani Email <wxs7855@autuni.ac.nz>	

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

Appendix D: Heuristic Evaluation

Heuristics Evaluation of [enter product name]

By [Enter Your Name] **Date** [Enter Date]

1. Visibility of system status

Always keep users informed about what is going on.

Provide appropriate feedback within reasonable time.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

2. Match between system and the real world

Speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms.

Follow real-world conventions, making information appear in a natural and logical order.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

3. User control and freedom

Users often choose system functions by mistake.

Provide a clearly marked "out" to leave an unwanted state without having to go through an extended dialogue.

Support undo and redo.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

4. Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing.

Follow platform conventions.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

5. Error prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

6. Recognition rather than recall

Make objects, actions, and options visible.

User should not have to remember information from one part of the dialogue to another.

Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

7. Flexibility and efficiency of use

Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user so that the system can cater to both inexperienced and experienced users.

Allow users to tailor frequent actions.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

8. Aesthetic and minimalist design

Dialogues should not contain information which is irrelevant or rarely needed.

Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

9. Help users recognize, diagnose, and recover from errors

Expressed in plain language (no codes)

Precisely indicate the problem

Constructively suggest a solution.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

10. Help and documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation.

Help information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Evaluation

[Enter your observation and evaluation of the degree to which this Heuristic has been satisfied. Use as much space as you see fit.]

Appendix E: Observation Sheet

Project: _______________ Experimental Num: _____________

Date: _________________ Nurse Name: __________________

Observed By: ___________ Patient Name: _________________

Time	Observations, Comments, Notes